ANNUAL CONVENTION, DETROIT, MICH., MAY 21-25, 1923

VOL. 9 NO. 6 NOVEMBER, 1922

PROCEEDINGS 42ND YEAR

JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

PUBLISHED IN JANUARY, MARCH, MAY, JULY, SEPTEMBER AND NOVEMBER

BY THE

AMERICAN WATER WORKS ASSOCIATION

AT MOUNT ROYAL AND GUILFORD AVENUES, BALTIMORE, MD.

SECRETARY'S OFFICE, 153 WEST 71ST ST., NEW YORK

EDITOR'S OFFICE, 16 WEST SARATOGA STREET, BALTIMORE, MARYLAND

Subscription price, $7.00 per annum

Entered as second class matter April 10, 1914, at the Post Office at Baltimore, Md., under the act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917;
authorized August 6, 1918

JOURNAL
OF THE
AMERICAN WATER WORKS ASSOCIATION

The Association is not responsible, as a body, for the facts and opinions advanced in any of the papers or discussions published in its proceedings
Discussion of all papers is invited

Vol. 9 NOVEMBER, 1922 No. 6

THE USE OF STEEL PIPE IN WATER WORKS[1]

By G. A. Elliott[2]

The subject of steel pipe is a broad one upon which volumes might be written. There are many subdivisions of the matter, any one of which would furnish the text for a paper in itself. Probably a brief discussion of some of the points that have been observed, or followed in practice, might be of interest. Necessarily the paper will deal with Western experience, more particularly with that on the Pacific Coast. Most of the experience of the writer regarding the life of plate pipes, has been in connection with riveted wrought iron mains. The early use of pipes of this sort in the West was in connection with hydraulic mining. Although the date cannot be definitely fixed, it is believed that as early as 1852 riveted iron pipes were used in the hydraulic mines of California. The plates for many of these pipes were imported from England. Due to the fact that the field joints were telescoped, the pipe was known locally as "stove pipe." Although hydraulic mining was discontinued many years ago, some of these old pipes were still in use for local water supplies in the small mountain villages a few years ago. The writer has examined some of them over sixty years old, and while in general

[1] Presented before the Philadelphia Convention, May 19, 1922.

[2] Chief Engineer, Spring Valley Water Company, San Francisco, California.

the coating had practically disappeared, the metal showed only a very slight, evenly distributed rusting, with but little pitting.

The Spring Valley Water Company was one of the early users of riveted pipe. Under the direction of Mr. Hermann Schussler, then Chief Engineer of the Company, a 30-inch no. 12 gauge riveted iron pipe, 15 miles long, was laid in 1868. The last mile of this main was replaced early this year, after having been in continuous use for fifty-four years. Fully 60 per cent of this section was in very good condition upon removal. At the present time 8 miles of 30-inch no. 12 gauge riveted iron pipe, laid in 1870, is used in bringing part of the supply to San Francisco. A still later riveted iron pipe is the 44-inch no. 6 gauge line, now 37 years old, used as part of the supply system, and which, so far as can be ascertained from frequent inspection, seems to be in practically as good condition as the day it was laid. All of these pipes are laid in a light, well drained soil free from alkali. Since 1888 this Company has used two 16-inch submarine lines of steel tubing crossing San Francisco bay. These lines are about 6000 feet long, and at very low tides are open to inspection for a part of their length. No signs of deterioration can be detected, the only mark apparent to the eye being a slight dent in the top of one pipe, caused by the keel of a small schooner.

The writer attributes the long life of these plate pipes to the coating and the character of the soils in which they are laid. The pipe dip used for the mains listed above, is one developed many years ago, consisting of a heated mixture of coal tar and asphaltum.[3] Later pipes laid in western cities have been dipped in ordinary asphaltum, a by-product of the refining of crude oil. This latter dip seems to become brittle and scales off, particularly during the handling of the pipe from the pipe works to the trench. During the past few years the custom of wrapping the dipped pipe with a composition paper has become prevalent. It costs only a few cents a foot additional, but is well worth the expenditure as an insurance against the breaking off of the coating next to the metal. Experience in connection with some of the long steel pipe lines laid in the alkaline soils of the San Joaquin Valley, which have been dipped in asphaltum and wrapped, indicates that the wrapping is well worth while. Probably a description of the method of using this protective covering would be of interest.

[3] Detailed description of dip and method of application, see page 323 "Waterworks Handbook," Flinn, Weston and Bogert.

After manufacture, the pipe is to be cleaned of dirt, scale and rust, and dipped in asphaltum at a temperature of 360° F. and is to remain in the kettle until the metal has attained the temperature of the bath. After the pipe has been dipped it is to be spirally wrapped with mica covering, wrapping to be put on under a tension of not less than fifty (50) pounds per eighteen (18) inches width of wrapping. The ends of the wrapping at the joint connections are to be finished off by sealing with hot asphaltum.

The mica covering shall be of felt, which has been thoroughly saturated with a high melting point bituminous compound, containing not less than twenty-five (25) per cent by weight of an alkali resisting mineral. The finished product shall weigh not less than three and six-tenths (3.6) pounds per square yard. Flaked mica shall be applied to the side of the coating which will be on the outside of the pipe, in such quantities as to give the best results.

A twelve (12) inch strip of the covering long enough to give a four (4) inch longitudinal lap is to be furnished with each section of pipe, together with the necessary asphaltum for wrapping and sealing the field joints.

The cost of wrapping a 30-inch pipe in addition to dipping, was 30 cents per lineal foot.

In general, the long life of the pipes mentioned above may be ascribed to the coating. The submarines have now been exposed to the action of salt water for over 30 years, without any evidence of deterioration. This pipe was galvanized and then dipped with a double coat of coal tar and asphaltum mixture. It has been the experience of the writer that where plate metal pipes have been carefully coated with a satisfactory protective covering material, and then laid in ordinary well drained, light soils, it is not unreasonable to expect a life of from forty to fifty years. A good coating will withstand the effect of a certain amount of alkali, but this is a matter of degree and instances are not wanting where pipes have been seriously attacked in less than five years. A satisfactory protective coating is just as important as a proper grade of metal.

In addition to other factors, the use which a pipe is to be given has a considerable effect upon the life. By use is meant the distinction between mains laid in the distributing system and those used for the transmission of the supply from the source to the city reservoirs. All of the examples given above are of pipes laid for transmission purposes; in other words, the pipes when laid are usually undisturbed for long periods of time. In the distributing system, mains are subject to more or less disturbance and exposure due not only to the operations of the waterworks in making connections, but are also exposed to damage from the work of other utilities. Careless handling of excavating tools often results in at least a

scratch clear through the coating, if not the removal of several square inches of surface, with the inevitable result that pitting and rusting begin immediately. With the smaller steel mains the connections for services are often responsible for the beginning of corrosion.

At present prices it is doubtful whether it pays to use steel pipes in the distributing system so far as the smaller sizes, such as 6 to 12-inch diameters, are concerned. Of course, frieght enters largely into the final cost of material, particularly that which is used on the Pacific Coast. A steel pipe of any type of sufficient thickness to stand the wear and tear of handling during its life, will cost as much

FIG. 1. PLACING A 200-FOOT LENGTH OF PIPE IN THE TRENCH

in place as a cast iron pipe of similar size. For the larger sizes this is not the case, however, and under some conditions steel is as desirable as any other metal. In practically all large cities a percentage of the larger distributing mains is riveted pipe. In San Francisco one of the principal feeders from the distributing reservoirs is a riveted main, tapering from 44 to 30-inch diameter. Excepting a replacement of about 1000 feet necessitated by electrolysis, the main is in very good condition after thirty-seven years of use. This pipe, however, is not tapped for service connections and consequently is not disturbed. All cross connections to street mains were made at the time the pipe was laid.

The general use of modern welding methods has done much to popularize the use of steel pipe. For the last four years the Spring Valley Water Company has used a welded field joint on riveted

pipe in preference to either the riveted or lead filled joint. Contrary to expectations, the heat of the welding did not open up the longitudinal riveted seam at the joint. The practice is to weld together enough lengths to make about 200 feet of pipe on the edge of the trench, and then lower the piece into place. The number of bell holes is reduced, and the ease of working on the level ground rather than in a hole results in greater speed and reduced costs. A recent 30 by $\frac{3}{16}$ inch line cost per joint for labor and material $6.00

FIG. 2. AN 8-INCH OUTLET BRANCH WELDED ON THE UPPER HALF OF A 30-INCH MAIN IN ORDER TO AVOID A PARALLEL 4-INCH GAS PIPE

for welding, as compared to $8.00 for a riveted joint. All of the outlets from this main were made by cutting and welding appropriate sized pieces of steel tubing to the side of the main. In a distributing system this is a great help, as at street intersections where other underground utility structures parallel the pipe, the connections were made near the top or bottom of the 30-inch main, thus enabling the branch pipe to pass over or under the obstruction without the use of bends. Not only was the welding process used for making joints and connections, but all of the bends were made in

the field by the use of the same agency. To make a 90 degree elbow for instance, a piece of straight 30-inch pipe of sufficient length was taken and four wedge shaped cuts, each covering an angle of $22\frac{1}{2}$ degrees, were marked with chalk. These pieces were then burned out of the pipe, leaving however a small untouched strip about 2 inches long at the back of the pipe at what would be the apex of the angle, for the purpose of holding the four pieces in place. The remainder of the operation consisted of bending the pipe until the

Fig. 3. A 90 Degree Bend Made in the Field From a Piece of Straight 30-Inch Pipe by Burning Out Sections and Welding

edges were in contact and welding them. The convenience of this method alone would suggest its use, but there is no doubt that taking the cost of the work as a whole, a substantial economy was effected. The pre-determination and purchase of angles, where large riveted pipe is laid in city streets, has never been satisfactory in the writer's experience, as one never knows until the trench is excavated just what artificial obstructions are to be overcome. The delay incidental to necessary changes is reduced to a minimum with a welding outfit on the job.

It may be of some interest to discuss briefly the effect of age on the carrying capacity of large plate pipes. This is a subject which has received a great deal of competent investigation. There appears to be a somewhat different experience in various parts of the country in the progressive reduction of carrying capacity. Some of the Western waters seem to produce this effect to a smaller degree than is customarily expected. Some years ago tests were made on several riveted lines in the vicinity of San Francisco to determine accurately their carrying capacity. All of these pipes had been dipped with the mixture of coal tar and asphaltum mentioned before. The results obtained are summarized in the following table.

SIZE	LENGTH	AGE	WILLIAMS AND HAZEN VALUE OF "C"
inches	*miles*	*years*	
36	21.5	23	107.5
36	6.7	23	123.0
54	3.2	8	109.0
44	5.1	27	97.9
44	4.3	27	89.1
44	5.5	13	113.5
30	7.5	42	110.0
30	5.0	4	114.0
30	1.0	46	110.0

The two instances where the value of "C" was below 100 occurred in pipes that had a large number of both horizontal and vertical bends, and in one case a piece of 37-inch diameter was necessarily included in the length tested. In general the interior of all of these pipes is in very good condition. Experience with plate pipes on the Pacific Coast shows that nearly all deterioration is from the surrounding soil and very seldom occurs to any great degree on the inside. Sponge growth occurs at certain seasons on the interior of the pipes. Apparently, in the case of the pipes tested, neither growths nor deterioration had a marked effect on the carrying capacity.

The writer's preference is for cast iron mains for general use in the distributing system, particularly those which are to be tapped for services. However, for transmitting the supply from the source to the distributing system, and possibly the large feeder mains in the distributing system, particularly in locations not subject to frequent disturbance, the plate metal pipe has many advantages which recommend its use.

CAUSES OF FAILURE IN CAST IRON PIPE[1]

By F. A. McInnes[2]

In Boston, during the past twelve years, nineteen failures of cast iron water pipe, 16 to 48 inches in diameter, have occurred; nine of them due to settlement upon an unyielding support, three to accident (in two cases blasting, and in the third case the operations of a public service corporation), two to freezing, one to imperfect casting, two to demoralization of metal in "bad ground;" in two cases no reason for failure was apparent. As usual the fatal rigid bearing was the greatest offender. Eternal vigilance, expressed in unremitting inspection on the part of the Water Department, will alone minimize the danger from this cause in city streets. The pipe may be originally laid in a safe location, yet disaster may easily follow from the subsequent construction of sewers, conduits, subways, etc., under or adjoining it. All the failures of this kind mentioned above were due to settlement upon structures built after the pipe was laid, and all might have been avoided had reasonable care been taken to provide the necessary clearance around the pipe.

It is not my intention to discuss the damage resulting from electrolysis, bad ground, improper filling, undue external loading, settlement, etc., nor to go at length into the imperative necessity that cast iron pipe be well made, properly laid and carefully protected from adverse conditions after being put in service. Much might be written on these points, but I will leave that task to others. I propose to call attention briefly to a probable cause of failure neither so much discussed nor appreciated. I refer to the quality of the pipe iron. This vital feature has not been sufficiently safeguarded in our specifications, which require the test bars to support a centre load of 1900 pounds (N.E.W.W.) or 2000 pounds (Am.W.W.) and to show a deflection of 0.3 inch before breaking. The weak spot in these requirements lies in the fact that no direct connection is made between the loading and deflection with the result that in many

[1] Presented before the Philadelphia Convention, May 18, 1922.

[2] Division Engineer, Public Works Department, Water Division, Boston, Massachusetts.

cases the test bars do not show 0.30 inch deflection until the load is in excess of 1900 or 2000 pounds, often times largely in excess. 2183 test bars broken by the Metropolitan Water Board of Massachusetts during the past nine years give the following results:

3 bars showed 0.18 inch deflection at 1900 pounds.
5 bars showed 0.19 inch deflection at 1900 pounds.
33 bars or 15 per cent of total number showed 0.20 to 0.21 inch deflection at 1900.
389 bars or 18.0 per cent of total number showed 0.22 to 0.24 inch deflection at 1900.
229 bars or 10.5 per cent of total number showed 0.25 to 0.28 inch deflection at 1900.
437 bars or 20.0 per cent of total number showed 0.28 to 0.30 inch deflection at 1900.
905 bars or 41.5 per cent of total showed less than 0.30 inch deflection at 1900.
456 bars or 21.0 per cent of total number showed 0.31 to 0.34 inch deflection at 1900.
490 bars or 22.5 per cent of total number showed 0.35 to 0.37 inch deflection at 1900.
136 bars or 6.0 per cent of total number showed 0.38 to 0.40 inch deflection at 1900.
3 bars showed 0.42 inch deflection at 1900.
2 bars showed 0.43 inch deflection at 1900.

These results indicate metal of widely different quality. With a test bar deflection at 1900 pounds ranging from 0.18 to 0.43 inch, we may safely conclude that the iron varied from "very hard" to "very soft." Omitting the extreme cases, the deflection at 1900 pounds ranged from 0.22 to 0.37 inch, a condition far from satisfactory.

Water pipe iron, to insure the required resiliency and the necessary strength, should show a test bar deflection of approximately 0.3 inch at 2000 pounds with an increased deflection of approximately 0.03 inch for each increase in load of 200 pounds above 2000 pounds.

The question naturally arises, "Why not specify the composition of the iron, stating just what percentage of the different elements will be allowed, as is done in the manufacture of steel?" There are practical objections to this course based on the differences in ores and coke throughout the country, on the necessarily different composition of thick and thin pipe, on the practical difficulty of making such a provision effective, on the possible undesirability of specifying both physical characteristics and composition of metal.

The writer, however, believes that the permissible sulphur content at least should be specified. With this provision, together with a logical relation between flexure and breaking load fixed in the test bar requirement, a long step forward towards uniform and satisfactory iron will have been taken.

It has been the practice of the Boston Water Department to analyze the metal in a broken or cracked pipe, and the following determinations represent some of the results obtained over a period of approximately twenty years. Many other analyses, entirely above suspicion, have been made in the same period.

YEAR	SIZE	SIL.	SUL.	MAN.	PHOS.	C.C.	G.C.	REMARKS
	inches							
1920	8	1.32	0.177	0.85	0.64	0.82	2.70	Pipe broken in middle of length when unloading from truck
1919	12	1.66	0.205	0.28	0.75	1.38	1.71	Sleeve broken when water was turned on
1918	8	1.74	0.233	0.45	0.83	1.30	2.20	Pipe broken when water was turned on
1915	10	1.37	0.171	0.57	0.75	0.72	2.68	Pipe broken in transit from foundry
1915	12	1.65	0.185	0.48	0.75	0.69	2.70	Pipe broken in transit from foundry
1915	10	1.35	0.133	0.43	0.79	0.64	2.74	Pipe broken in transit from foundry
1915	10	1.33	1.21	0.40	0.80	0.64	2.70	Pipe broken in transit from foundry
1915	12	1.47	1.21	0.34	0.80	0.93	2.40	Pipe broken in transit from foundry

Six breaks occurred between October 19 and December 5, 1900, in a 48-inch supply main of the Boston System, laid in 1869, following an increase in working pressure of 15 pounds. The analyses of the iron in these cases were as follows:

	SIL.	SUL.	MAN.	PHOS.	C.C.	G.C.
1	4.05	0.07	0.90	1.00	0.04	2.38
2	4.25	0.017	0.90	0.79	0.08	3.56
3	4.10	0.037	0.83	0.86	0.08	2.85
4	4.18	0.027	0.93	0.90	0.08	3.06
5	4.27	0.051	0.86	0.928	0.06	2.62

When the writer was employed in St. John, N. B., 1916–1917, one of the two 24-inch mains supplying the city failed several times, as it had been in the habit of doing at intervals in the past. The pipe was cast in England many years ago. The following are analyses of the metal in the broken pipe in three cases:

	SIL.	SUL.	MAN.	PHOS.	C.C.	G.C.
1	2.94	0.035	1.08	0.99	0.56	2.59
2	2.36	0.068	1.22	1.00	0.51	2.79
3	2.80	0.03	1.05	0.90	0.58	2.80

The following analyses of a 24-inch main broken in the Hartford, Conn., system in 1921, have come to my attention:

	SIL.	SUL.	MAN.	PHOS.	C.C.	G.C.
1	2.22	0.094	0.36	1.39	0.07	2.92
2	2.61	0.10	0.23	1.86	0.03	2.77

Some of these determinations may safely be termed "horrible examples;" witness the Boston 48 inch with C.C. 0.04, Sil. 4.05 and the Hartford 24 inch with C.C. 0.03, Phos. 1.86. One of them, the St. John 24 inch, is in the freak class. The remainder, particularly those in which the sulphur content is abnormally high, warrant the conclusion that the quality of the iron was a contributing, if not the direct, factor in the failure of the pipe. The broken pipes were cast in main pipe foundries throughout the United States, with two exceptions, namely, the St. John 24 inch which was made in England and the sleeve broken in 1915, which was cast in a small jobbing foundry in Boston. As a rule, two specimen pieces, taken from different parts of the broken pipe, were submitted for analysis and in no case was a substantially different result obtained from the bell and spigot end of the same pipe.

Cast iron pipe is not a homogeneous material. When pig iron and scrap iron are melted and made into water pipe, the resulting cast iron must vary to some extent in its physical characteristics, owing to differences in the material used in the cupola and to the methods employed in moulding, cooling, etc. The process of manufacture demands a high degree of skill and oversight of the product to maintain the uniform quality desired. That this condition does

not always exist is apparent to those familiar with the output of cast iron water pipe. There are notable exceptions where this criticism does not apply, but on the whole it would appear that the general standard of manufacture might be raised to the advantage alike of maker and consumer, to the end that a well coated pipe of uniform and sufficient strength, equal at least to the best of the present product, may be absolutely depended upon.

The writer is one of those who believe in cast iron pipe for water works distribution and supply systems, recognizing it to be best suited to meet the conditions usually found, and as its friend, advocates the application of more scientific methods in its manufacture than now obtains in many cases.

CAST IRON WATER PIPE FOR PRESSURES HIGHER THAN ALLOWED BY CURRENT SPECIFICATIONS[1]

By C. E. Inman[2]

Criticism of the weights of, and stresses in, cast iron pipe manufactured under the specifications of this Association doubtless leads to the request for a brief experience paper. It should not seem in the least boastful to say, in complying with this request, that the "experience" covers many years and work as foreman, supervisor of construction or as superintendent in a number of different and widely separated cities. The weights of pipe used in those cities were fixed by engineers, or in some cases by the author. Speaking generally, those weights fall below the weights in the Association's specifications as the following table will indicate.

Weight in pounds per foot, including bells, for various diameters pipe

INCHES	POUNDS
6	28.92
8	40.50
10	56.17
12	73.75
14	90.67
16	106.75
18	126.67
20	153.43
24	210.33

Lake Shore Foundry standard weights for pipe

INCHES	POUNDS
6	33
8	42
10	60
12	75

The author began his water works experience in the year 1885 and worked under excellent contracting firms, who employed able engineers.

It was the custom to depend on the engineers' requirements for the proper weight. The foundries were willing to furnish pipe under

[1] Presented before the Philadelphia Convention, May 17, 1922.

[2] Commissioner and Superintendent, Water Works, Warren, Ohio.

the engineers' specifications with a standard test, often under strict inspection.

A good quality of material was not always received. This caused some replacements when the time came to test the systems, but the cost for new pipe and labor was billed against the foundry furnishing the pipe, paid without hesitation upon assurance that the pipe had been carefully handled, properly laid and showed foundry defects.

Comparison of the above weights with the present A.W.W.A. specifications shows that some are even lighter than Class "A." In each town or city where this weight pipe was used, the pressure was always run up to 150 pounds per square inch on the completion of the work and in one city the pressure was increased every day at noon to 120 pounds, which was continued for 25 years. In this particular city, as well as in a number of others, there has occurred, as far as the author has been informed, only one failure on account of light weight pipe and that is mentioned below.

An employee of an eastern city who has been connected with the city water department for over 30 years writes thus: "In regard to pipes bursting, I do not think there has ever been any, unless there were flaws in the castings. The 'A' pipe seems to stand the pressure as well as the 'B.'"

The author has filed letters from those in charge of water departments in most of the cities herein referred to and after 27 to 37 years of service there are no criticisms regarding the original service mains or of those laid more recently.

Allow me to quote again from letters received, first from a water works in Massachusetts built in 1885.

> The writer has used some Class E, New England pipe but will use Class A American, in the smaller sizes, at least, in the future. We have had no trouble whatever with cracks due to pressure, and believe that Class A pipe is good for working pressures up to at least 100 pounds.

Second, of a city in Ohio.

> We might just as well buy Class A, for we did use some here, and, to my knowledge, we have not had any burst pipe due to its weight, as all our fractures were straight around the pipe as though caused by settlement. I think we will try Class A on our next extension. We carry 60 pounds domestic pressure and 100 pounds for fire.

Third, of a city in Wisconsin.

A pressure of 65 pounds is maintained at the plant. This has been raised to 100 pounds for a few fires. We have had no failures of the old pipe due to excessive water pressure or water hammer, within the past ten years.

In the city of Warren, Ohio, where the author is now with the Water Department, the plant was built in 1887 by Samuel R. Bullock & Co. It comprised 12 miles of mains and since then 46 miles have been added.

The original pipe compares with Class "B," while many miles of the pipe as added from time to time were even lighter than Class "A," yet all have stood the test of years of service with a domestic pressure of 60 pounds and fire pressure of 100 to 120 pounds, with sometimes more when called for. In all these years only one pipe burst from pressure and then the gauge went over 150 pounds.

In 1909 the Warren, Ohio, works were appraised and showed over 2000 tons of pipe. If we suppose the next heavier class of pipe had been laid for the sizes and mileage at the date of the appraisal, it would have added approximately 500 tons. This quantity at present quotations, say $40.00 per ton, would increase the cost $20,000. For the period from 1909 to 1922, or 13 years, the interest compounded yearly together with the principal, would amount to $42,600. Can this Association indorse such expenditure?

During the past season we had occasion to make several Smith taps in the city mains and found the thicknesses as follows:

12 inch pipe	34 years old	0.65 of an inch thick, corresponding to about half way between Class "B" and "C"
8 inch pipe	5 years old	0.51, equals Class "B"
6 inch pipe	With age from 34 years down to 4 years	With thickness of 0.55, equals Class "D" 0.50, equals Class "C" 0.47, equals Class "B" 0.42 and 0.37, equals lighter than Class "A"

A foundry test of 300 pounds to the square inch with vigorous hammer blows was required for the added pipe. All have been in service under identical working pressures as mentioned above.

The following quotation published by the late Geo. A. Ellis, at one time city engineer of Springfield, Mass., and later a member of this Association, seems still worthy of the attention of our membership. It was published about the year 1887.

WEIGHTS OF CAST IRON PIPES

This has been the subject of discussion and experiment among engineers for a long time, and the general verdict seems to be that we should apply the same fair, common-sense principles to this question as to any other, and not use a 6-inch pipe weighing 40 pounds to the foot, because somebody else does, when one weighing 28 pounds will answer the same purpose with equal safety. After a careful study of all the conditions under which cast iron pipes are used, it would appear that a factor of safety of 5 is ample to cover all the reasonable faults of manufacture, danger of handling and shock while under use.

The opinion of Mr. Ellis was based upon his extensive experience. Other engineers and superintendents have reached similar conclusions.

If Classes "A," "B," "C" and "D," under 20 inches in diameter, are tested at the foundry under 300 pounds pressure, all poured from the same quality of metal, why recommend class "A" for 43 pounds, Class "B" for 86 pounds, Class "C" for 130 pounds, and Class "D" for 173 pounds pressure per square inch.

Disturbance of the ground, as in sewer construction, causes unexpected stresses in water mains, but even then a tough close grained pipe free from dross and blow holes, with tensile strength according to the specifications, will be found more satisfactory than a heavier pipe without these qualities.

A friendly discussion on the above subject may mean the elimination of one or two classes of pipe as now stipulated, with a higher pressure allowable for the remaining classes. The same satisfactory results may be obtainable with a saving of money.

DISCUSSION

Mr. J. N. Chester:[3] I wish to add to the inference of Mr. Inman's paper that higher pressures may be used than the specifications now in vogue and to cite you a well defined instance. There are here tonight members of that organization formerly known as the American Waterworks and Guaranty Company, now the American Waterworks and Electric Company. I became associated with that organization in 1899, and they were then laying about 100 miles of pipe a year, and probably 85 per cent of that was 6-inch. The general manager, Mr. Purdy, who is still the Vice President, and a man who has few

[3] Consulting Engineer, Pittsburgh, Pa.

peers in the waterworks business, had what I thought a queer streak in him in that he contended that 30-pound 6-inch pipe was heavy enough for any place. Their specifications then, and I believe they continue still, called for all their 6-inch pipe to be 30-pound pipe. Now I went on laying that because I was compelled to, but I soon became converted because we had no more trouble with 30-pound 6-inch pipe. Pressures varied all the way in our distribution systems from 25, in some of the flat western cities, up to over 125 pounds in some of the mountain cities of western Pennsylvania. The climax came, however, when we took over the South Pittsburgh Water Company where the hills varied 300 and 400 feet in height and we pumped water twice, the first time against 165 and the second time against 185 pounds. I anticipated that Mr. Purdy would weaken on the 6-inch 30-pound specification, but he stood pat and we laid miles and miles of it in South Pittsburgh, and not the majority but a great deal of it was subjected to 250 and 300 pounds working pressure. It stood the test and is standing it today. They have no more breaks in the South Pittsburgh Water Company, with the pressure varying from 35 to 300 pounds on the 30-pound 6-inch pipe, than they would have if they had laid class D. I am sometimes constrained, from the experience I had in that connection, to believe that those who formulated the present requirements, although I believe they used their best judgment and did not intend anything ill or evil to us, loaded the waterworks plants of this country with a great deal more cast iron than the conditions of service warranted placing below the ground. I am still willing to use 30-pound 6-inch pipe anywhere under ordinary conditions and under some extraordinary conditions. Just how far this will carry out in sizes larger than 6-inch I have never experimented, because when we left 6-inch pipe we used ordinary formula. We bought very little beyond class B and never used class D unless it was for discharge lines.

Mr. W. F. Wilcox:[4] I can confirm what Mr. Chester says. For many years in the South we laid only 30 pound 6-inch and 56-pound 10-inch pipe. I know of at least 25-pound pipe where the pressure was as high as 150 pounds. Some of that pipe has been in use since 1888 and is still good, and the per cent of fracture is very small. But there is another point about the question that has something to

[4] Consulting Engineer, Birmingham, Ala.

do, I think, with our weights under the old specifications. We rarely went over 19,000 pounds tensile strength. Now we have gone on up into the high tensile strengths and have laid class B pipe that had 36,000 pounds tensile strength, and it has blown up like glass rods.

Mr. C. E. Inman:[2] I had a talk handed me today with a few pages by Mr. Alexander Potter, who is called back to New York, in reference to some pipe tested in Texas, that was laid in 1877 and tested in 1912. A section of the city was taken comprising approximately two miles of pipe and the pressure upon it was used to see how good it was. The 4-, 6-, 8- and 10-inch were all class A pipe; the 12-inch in this section was class C. They ran the pressure up to 160 pounds, by pumping into the system with a fire engine, and did not burst anything.

Mr. Leonard Metcalf:[5] Just one word to call the attention of the members, who may be interested in looking it up, to the fact that in the discussions of the New England Waterworks Association standard specification, there will be found reference to these pipe weights and to their very general use in New England for a considerable period of years. They correspond to class A of the New England Waterworks Association weights, which were somewhat lighter than the American Waterworks Association weights. Those pipe sizes were not only 6-inch, but 8, 10 and 12. I know of such lines, miles of them, that have been used under pressures of 125 pounds for decades now.

[5] Consulting Engineer, Boston, Mass.

PUBLIC WATER SUPPLIES IN ILLINOIS[1]

By Harry F. Ferguson[2]

A good public water supply is the most important public improvement in any municipality. By good water supply is meant a supply that at all times is adequate, clear, of reasonably satisfactory mineral quality for all domestic uses, and especially of safe sanitary quality. Any public improvement is made for the convenience or comfort that it will provide. Paved streets, electric lights, municipal buildings, provide convenience and comfort, but a public water supply not only provides these but also improves health and sanitary conditions. Paved streets, electric lights, good public buildings are desirable, but a municipality might struggle along without them. Without a city's water supply, however, within a few hours serious health conditions would exist and a fire might wipe out the entire community.

The Illinois State Department of Public Health, since the creation of the Division of Engineering and Sanitation in 1915, has been making careful examinations of all public water supplies and has been coöperating with city officials, civic organizations, waterworks officials, engineers, and others interested in the improvement of existing unsatisfactory water supplies, and in the installation of new water supplies. Detailed reports are prepared on the basis of each examination, copies of which are placed in the hands of the persons responsible for the operation of the waterworks or the installation of the new public water supply.

Public water supplies have been installed in 449 municipalities. In addition records have been obtained of the public water supplies at 10 unincorporated communities, at the 28 State institutions and the 7 Federal institutions, army posts, and naval stations in the State, making 494 in all.

Before presenting the history of the development of public water supplies in Illinois and the present situation relative to public water

[1] Read at annual meeting of Illinois Section, Champaign, March 29–30, 1922.

[2] Chief Sanitary Engineer, Illinois State Department of Public Health.

supplies, certain statistics relative to the State should be considered. Illinois was admitted into the Union in 1818 as the twenty-first State. The State has an area of 56,043 square miles and is divided into 102 counties. The population in 1920 was 6,485,280 which represents an increase of 15 per cent since 1910. The increase for the same period for the entire United States was 14.9 per cent, and thus Illinois is having an average growth as compared to the entire United States. Forty-six of the 102 counties increased and the other counties decreased in population in the decade 1910-1920.

The increase in population has been greater in proportion in municipalities than in the rural districts, which means that, even if no new public water supplies were installed, the proportion of the population served by public water supplies would be increasing at a slightly faster rate than the total population, assuming distribution systems are extended to serve the increased populations in cities. The Federal census shows that for the past three decades the proportion of the population in Illinois in municipalities of 2,500 and over was 54.3 per cent, 61.7 per cent, and 67.9 per cent. Municipalities of even less than 2,500 should be considered as urban instead of rural, as defined in the Federal census reports. Especially is this true when considering public water supplies, for under ordinary conditions a community having a population of only 300 or perhaps less might well have public water-supply installations, as well as other public improvements.

Ordinarily the term "public water supply" is applied to a supply serving a community, whether or not such a community is incorporated, but in the remainder of this paper the term will be limited to supplies for incorporated communities. The 10 unincorporated communities having public supplies and the State and Federal institutions will be omitted. According to the 1920 Federal census the total number of public water supplies, for incorporated communities, that would be possible in Illinois is 1,111 for there is that number of municipalities, of which 259 are incorporated as cities, 31 as towns, and 821 as villages. The development of incorporated areas (municipalities) in Illinois is presented in figure 1, which shows the number of municipalities incorporated each year. The diagram shows a fairly uniform rate of increase in the number of municipalities from about 1850 until near 1910 from which time the rate of increase has been slower.

The distribution of population among the municipalities of different sizes is presented in table 1. This table shows that Chicago has about two-fifths of the entire population of the State, that 939

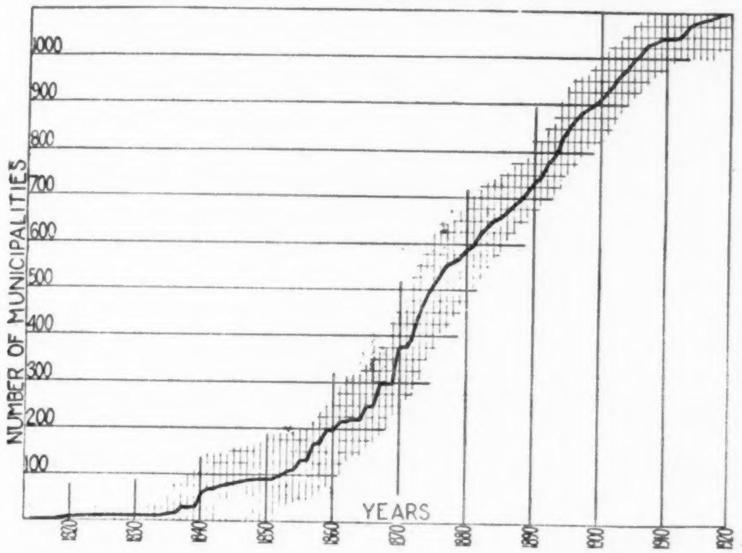


FIG. 1. DEVELOPMENT OF MUNICIPALITIES IN ILLINOIS

TABLE 1

Distribution of population among municipalities

POPULATION CLASSIFICATION	NUMBER OF MUNICIPALITIES	POPULATION	PER CENT OF TOTAL POPULATION
1,000,000 or more	1	2,701,705	41.5
50,000–100,000	4	267,722	4.1
25,000–50,000	12	432,588	6.7
10,000–25,000	27	406,143	6.3
5,000–10,000	47	324,046	5.0
2,500–5,000	81	273,474	4.2
Less than 2,500	939	678,312	10.5
Unincorporated areas		1,401,290	21.6
Entire state	1,111	6,485,280	100.0

of the total of 1,111 municipalities, or 84 per cent, have only one-tenth of the population, that about one-fifth of the population lives in unincorporated areas, and that the remaining three-tenths

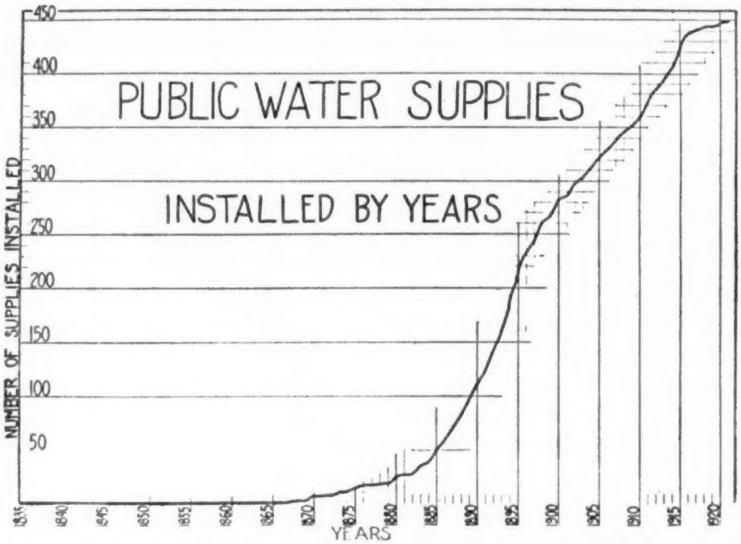


Fig. 2. Public Water Supplies Installed by Years in Municipalities in Illinois

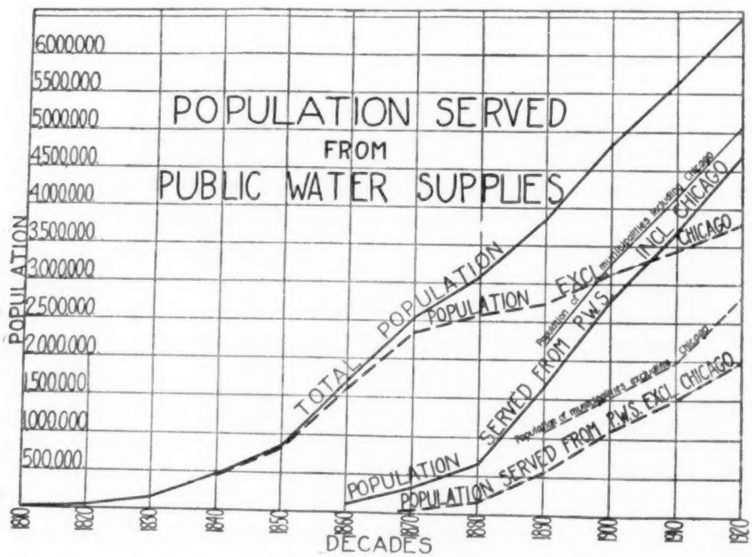


Fig. 3. Population Served From Public Water Supplies in Illinois

of the population are distributed comparatively evenly among five groupings of municipalities by population.

The number of public water supplies that have been installed in municipalities in Illinois and the rate of such development are presented in figure 2. The diagram shows a fairly uniform and rapid rate of increase in the number of supplies, beginning about 1885 and continuing until about 1916. The decrease in rate beginning with 1916 probably is the result of war conditions.

Figure 3 gives population curves for the entire State and for the State excluding Chicago, as recorded in the Federal census reports, and also curves showing the population served by public water supplies. This diagram indicates that following about 1885 the population served by public water supplies has increased at a slightly more rapid rate than has the total population. This is true for the entire State and for the State excluding Chicago, and has been the result of the increase in the number of public water supplies and also of the greater proportionate increase in population in municipalities as compared with the population increase in rural areas. This diagram also presents visually the fact that, because of the high rate of increase in population for Chicago, the rate of increase for the entire State has been higher than the rate of increase for the State excluding Chicago.

TABLE 2

Population served by public water supplies by decades

YEAR	POPULATION		POPULATION SERVED BY PUBLIC SUPPLIES	
	Entire State	Excluding Chicago	Entire State	Excluding Chicago
1840	476, 183	471, 713	4, 470	0
1850	851, 470	821, 507	29, 963	0
1860	1, 711, 951	1, 602, 691	109, 260	0
1870	2, 539, 891	2, 240, 914	339, 190	40, 213
1880	3, 077, 871	2, 574, 686	662, 882	159, 697
1890	3, 826, 352	2, 726, 502	1, 660, 327	560, 577
1900	4, 821, 550	3, 122, 975	2, 797, 690	1, 099, 115
1910	5, 638, 591	3, 453, 308	3, 696, 751	1, 511, 468
1920	6, 485, 280	3, 783, 575	4, 696, 381	1, 994, 676

Public water supplies in Illinois may be divided into three general classes; (1) those obtained from surface sources, (2) from drift wells, and (3) from rock wells. There are, in addition, sources such

as springs and abandoned mine shafts or workings, but supplies from such sources may be classified with the drift or rock well supplies, depending upon the formation from which the waters are derived. In general, the supplies for the northern portion of Illinois are obtained from rock wells and most of these wells penetrate St. Peter or Potsdam sandstone. The majority of the supplies for the central portion of Illinois are obtained from sand and gravel forming part of the glacial-drift deposits. Nearly all of the supplies for the southern portion of Illinois are derived from surface sources, for in that section supplies from wells would be either inadequate or so highly mineralized as to be unsatisfactory for general domestic purposes.

TABLE 3

Number of public water supplies classified by source and population served by each classified source

SOURCE OF SUPPLY*	NUMBER OF PUBLIC SUPPLIES	POPULATION SERVED 1920
Surface water	95	3,541,440
Drift wells	159	515,640
Rock wells	195	639,301
Total	449	4,696,381

* There are 8 municipalities, having a total population of 57,404, that have combined rock well and surface supplies; 4 municipalities, having a total population of 29,029, that have combined drift well and surface supplies; and 10 municipalities, having a total population of 65,687, that have combined rock and drift well supplies. Each of these 22 places have been included in one of the three classified groups in accordance with which source of supply constitutes the major source of the total water used.

Table 3 presents the number of public supplies obtained from the three classified sources and the population (1920 Federal census) served by such supplies.

This table shows that, although only one-fifth of all the public supplies have surface-water sources, these surface supplies serve about three-fourths of the entire population served by all public water supplies. This is, of course, because the large population of Chicago, served by Lake Michigan water, and also the municipalities north, south, and a few to the west of Chicago, that are also served by Lake Michigan water, influence this relationship. There are slightly more rock-well than drift-well supplies, but the average population served per supply is about the same, namely, about 3,000.

Table 4 analyzes the distribution of population served by public water supplies as regards classified sources.

This table shows that 92.5 per cent of the population of all incorporated communities are served by public water supplies. Since only 449 of the 1,111 incorporated communities have public water supplies, more than doubling the number of public water supplies would increase the population served by public supplies less than 10 per cent.

TABLE 4

Total populations and percentages of population served by classified sources of public water supplies

POPULATION-SOURCE CLASSIFICATION	POPULATION AND PER CENTS	
	Including Chicago	Excluding Chicago
Population of all municipalities in State	5,083,990	2,382,285
Population served by public water supplies	4,696,381	1,994,676
Per cent of population in all municipalities that are served by public water supplies	92.5	83.5
Population served by surface supplies	3,541,440	839,735
Per cent of population served by public water supplies that are served by surface supplies	75.4	42.1
Population served by drift-well supplies	515,640	515,640
Per cent of population served by public water supplies that are served by drift-well supplies	11.0	25.9
Population served by rock-well supplies	639,301	639,301
Per cent of population served by public water supplies that are served by rock-well supplies	13.6	32.0

The distribution of the municipalities that do not have public water supplies is presented in Table 5 according to population groups. The largest municipality that does not have a public water supply is Zion City (1920 Federal census 5,580). There are more municipalities having populations of over 300, that do not have public water supplies, than there are municipalities that have already installed such supplies, but the total population not served is comparatively small. Installing public water supplies in the 89 cities having populations of 1,000 or more, which do not have public water supplies, would reduce the total population of municipalities not now served by public water supplies by one-third.

A large number of new public water supplies should be installed in Illinois, but the magnitude of such installations will be small in

comparison to installations already made. In addition to the new supplies that should be installed there remains a large amount of development to be done before many of the existing public water supplies in Illinois may be considered to be satisfactory from the standpoint of domestic service, fire protection, and health and sanitary conditions. Additions and improvements to these existing supplies probably will require considerably more work and expenditures than the installation of supplies in the municipalities now without public water supplies.

TABLE 5

Number of municipalities that do not have public water supplies

Arranged by population groups

POPULATION GROUP	NUMBER OF MUNICIPALITIES WITHOUT PUBLIC WATER SUPPLIES		POPULATION FOR EACH GROUP	TOTAL POPULATION
	For group	Total		
5,000 up	1	1	5,580	5,580
3,000 to 5,000	7	8	26,190	31,770
2,000 to 3,000	9	17	21,896	53,666
1,500 to 2,000	16	33	27,225	80,891
1,000 to 1,500	56	89	68,005	148,896
750 to 1,000	64	153	55,481	204,377
500 to 750	120	273	72,005	276,382
400 to 500	91	364	41,047	317,429
300 to 400	109	473	38,126	355,555
Under 300	189	662	32,054	387,609

In discussing the population served by public water supplies, the total population of each municipality has been considered as served, but in reality there are a number of municipalities where only a portion of the population actually uses the public supplies and there are some where only a few people really use the supply. This limited use of many public water supplies is due to limited extensions of mains in some municipalities, the inadequacy of supplies in others, and the unsatisfactory quality of the supplies for domestic purposes in municipalities where the supplies are scarcely used, except for fire protection.

The inadequacy of supplies in some municipalities is the result of increases in populations, in others of the decreased yields of the sources, and, in some instances, the supplies have never been adequate for more than part of the populations and, as the number of

service connections increased, the inadequacy of such supplies has been locally realized. With few exceptions, where the supplies are of unsatisfactory quality they have been so since their installation.

The enlargement and improvement of existing public water supplies, combined with the installation of supplies in municipalities as yet without them, represent a large amount of work for engineers and others interested in water-supply development, even though the population of the State does not increase. With the increase expected in population of the State and the noticeable increasing desire of the people for better and more adequate water supplies, the development work to be done becomes great.

The minimum size of community that should have a public water-supply system may not be definitely stated. Communities of even a few dwellings, in those areas in Illinois where water is obtainable from rock or drift wells at comparatively low cost, might to the advantage of all property owners have public water-supply systems. The installation and operation costs of a single pumping outfit would be less than the cost for several private running-water-supply installations. This saving would tend to offset the cost of a distribution system and the remaining cost of the distribution system would be cheap fire and health insurance. It must be remembered, also, that a public water supply gives greater convenience and comfort, makes possible the better keeping of lawns, and improves the civic appearance of the community.

Communities in those areas in Illinois where surface supplies must be developed for public use have more expensive problems to meet and the smaller municipalities are at a disadvantage. For instance, in the southern portion of Illinois where practically all public supplies must be obtained from surface sources, the costs of such developments are much higher than for wells in central or northern Illinois. To develop a satisfactory surface supply requires a filter plant, and unless the municipality is on a stream having an adequate daily flow a dam and impounding reservoir must be constructed at considerable expense. It is frequently the case, also, that a suitable dam site can be obtained only at considerable distance from the municipality, which means a long force main and the hauling of coal to a pumping station at the reservoir or an electric transmission line. In urging communities to install public water supplies and otherwise helping to bring about such installations, efforts are not, therefore, necessarily concentrated on the larger municipalities as yet without such supplies.

An essential part of the examinations of public water supplies made by the Division of Engineering and Sanitation of the State Department of Public Health relates to their sanitary quality and adequacy. The adequacy of a supply affects the health and sanitary conditions in a community, though not as much, of course, as the quality. This has been evident in some communities where supplies have proved inadequate during the summer months of dry years. As a result insanitary conditions were created because of the curtailed use of plumbing and sewerage installations or people have resorted to the use of insanitary private wells. In one instance a hospital, where a number of patients were confined, had difficulty in obtaining water because of water shortage and decreased pressure.

A bad water supply is probably more dangerous to the public health than no public water supply, for in the absence of a public supply it is not likely that many wells would be contaminated at the same time, and thus only occasional cases of water-borne disease would prevail. But with a bad public water supply the whole community might be involved in a serious epidemic, and this has been actually the case in several municipalities in Illinois.

The studies made relative to the sanitary quality of water supplies include examinations of the sources of the supplies and the methods of handling the waters, as well as analyses of samples. This includes, of course, in the case of surface supplies the operation of water-purification plants or simply the sterilization of such supplies by liquid chlorine or hypochlorite if filters have not been installed. The water-purification plants in Illinois, their operation, and analytical control will be presented in a separate paper to be read at this meeting by Mr. Cowles, assistant sanitary engineer, of the department. In determining the sanitary quality of water supplies as delivered to consumers, consideration must be given also to the supplies even after pumped into the distribution systems, for cross connections between a public water supply of good quality as delivered to the mains and a polluted private or industrial supply may result in dangerous contamination of the public supply. In Illinois, within the past decade, two epidemics, each involving more than 200 cases of typhoid fever and over 15 deaths, as well as several smaller epidemics, have occurred because of the pollution of good water through cross connections with impure supplies.

Of the 449 water supplies in municipalities and the 10 supplies in unincorporated communities, 339, or 74 per cent, have been

classified as of good sanitary quality, 86, or 19 per cent, as doubtful, and 34, or 7 per cent, as bad. Of the water supplies at the 28 State institutions, the sanitary quality of 20 may be classed as good, of 7 as doubtful, and of 1 as bad. The water supplies at the 7 Federal institutions are all of good sanitary quality.

When the Department classifies a water supply as of good sanitary quality it means that analyses have shown that it was of satisfactory sanitary quality at the time samples were collected and careful inspection of the waterworks system indicated that the supply was not subject to contamination at the source, or in the handling and distribution. The "Doubtful" supplies are those supplies that show satisfactory results by analyses, yet inspections have shown that there are certain possibilities of contamination, though such possibilities are slight. "Bad" supplies are those supplies that are undoubtedly contaminated, such as surface supplies without treatment or which the physical examinations show are subject to fairly certain pollution. In a number of instances slight modification at the waterworks would make doubtful supplies satisfactory, and in other instances rather extensive improvements would be necessary.

All the public water supplies and the supplies at State institutions and Federal institutions and camps in Illinois are listed in a special bulletin issued by the Department, which bulletin is obtainable upon request. In it are recorded the population for each community, source of public water supply and its treatment, if any, and the sanitary quality of each supply.

The sanitary quality of a water supply is, of course, subject to change if improvements are made, and the department is always glad to learn at any time of any improvements, so that reinspections may be made and the recorded quality revised, if necessary, so that records of the department may be as complete and accurate as possible. Public distribution of the tabulation and classification of the public water supplies as regards sanitary quality has been helpful in bringing about improvements, for the department does not have authority at present to require doubtful or bad supplies to be made safe, but municipalities and especially chambers of commerce have disliked the unfavorable publicity and have been prompted, in several instances, to improve their water supplies.

LEAD SUBSTITUTES FOR PIPE JOINTS[1]

Mr. W. Luscombe:[2] I have never tried anything but pig lead. Some representatives, speaking to me of leadite, stated that in Philadelphia it is now being extensively used several blocks from here, on a considerable mileage of large mains under streets where it is extremely difficult to reach the joints. Philadelphia must have found it very satisfactory, or else they would not have used it. However, I have never used anything but pig lead, which I have always found satisfactory.

Mr. W. C. Hawley:[3] I have some 75 miles of pipe laid with leadite joints. It has been entirely satisfactory and is much less expensive. I figured that we have saved about 60 per cent in the cost of the joints during the recent war period. The other day my foreman brought in a piece of joint which was taken out of a ten inch pipe where the line had settled into a coal mine, and in breaking out the bell he had the joint in pretty nearly one piece. There was no evidence whatever of any deterioration in the metal. It was as perfect as any jointing material could be. We are using it under all sorts of conditions, in trenches four to four and a half feet deep, which stand the vibration due to the use of heavy automobile trucks, and we are using it under pressure up to 210 pounds and in sizes from four to thirty-six inches.

Mr. E. T. Cranch:[4] I would like to ask about the experience necessary in handling leadite. I have never used it myself. I have been approached by representatives to undertake it and have discussed it with several. The principal objection I could find is that I am told you are likely to overheat it and it is no good if it is overheated. I wonder what the experience has been in that line?

[1] Discussion at the Philadelphia Convention, May 18, 1922.

[2] Vice-President, Gary Heat, Light and Water Company, Gary, Indiana.

[3] Chief Engineer and General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa.

[4] Superintendent, Water Department, Petersburg, Va.

Mr. W. C. Hawley:[3] Leadite is different from lead and has to be handled differently, but, used with any intelligence, there is no reason why good results cannot be had. As far as overheating is concerned, that is the thing to do. It comes in the form of black powder and as it melts it should be stirred. It will froth and foam, and then as it gets a little too hot, it begins to thicken like a black oatmeal mush and that is the time to take it away from the fire or take the fire away from it, and to continue to stir it. It will thin down until it is like a thin black oil, and then it is ready to pour. If poured from the proper height, eight or ten inches, there is no difficulty at all. Anybody can use it, but it is just enough different from lead to require a little different treatment. We break in an Italian boy to pour the joints. It does not require expert labor. We get rid of all the trouble with caulkers and that sort of thing, and we find a saving, as I said, of 60 per cent in the cost of the joints.

Mr. J. E. Gibson:[5] I want to reinforce, if I can, what Mr. Hawley has said. I have used leadite now for about four years, and have found it entirely satisfactory. I did have difficulty when I started to use it. I got it afire and smoked everybody out of the community in that section, but now we have gotten on to it and find it very satisfactory. During the last two years we have rebuilt our filter plant, and, as we all know, the pipe gallery is forgotten until we begin to erect the pipes, and then we find we have four feet of space for six feet of material. We used leadite there and saved a good many dollars, because without leadite, if it had been necessary to caulk lead, we would have had to put in flanged pipes. We could pour the leadite in six inches of space and no caulking was needed. We did have leaks under those conditions in one or two cases. We had a stream pouring out of a twenty-inch connection that would fill a gallon pail in a few minutes, but after eight or ten days the leak stopped and since then we have painted the pipes without any difficulty whatever.

We cannot use it in water that will not rust We have in Charleston an artesian supply. It carries about 2000 grains per gallon of soda, a good mineral water for drinking and bathing, but it is not useful for anything else. Laundry work done with it is most splendid. It will wash clothing and it will come out beautifully white. That

[5] Superintendent, Water Department, Charleston, S. C.

water will not rust iron. I took out in 1921 some pipe placed in 1897. The threads were just as sharp as the day they were turned out of the die, the tool marks were still there but, after twenty-four hours' exposure in the salt air of Charleston, they were rusted. But there was a pipe absolutely clean that had been submerged for twenty some odd years. We have got the artesian pipe still in the ground, and people still want that for bathing. We have repaired a few joints with leadite on that, but it will not hold, so if you have a water that will not rust ordinary iron, I would not suggest that you experiment with leadite. It seems to have that quality of rusting tight like our old style rust joints that we made years ago.

Mr. W. F. Wilcox:[6] I do not know anything about leadite, but I was going to give an experience with pipe joints in our district. We laid two miles of 24-inch pipe carrying a million cubic feet of gas an hour under 10 pounds pressure. In that two miles of line we finally drove up 3500 leaks. We had to put in another line to carry two million cubic feet of gas an hour under 10 pounds pressure, and we put in a joint there by using one inch of untarred jute yarn, driving that up hard, and then drove in one inch of lead wool, then another inch of jute yarn and cast on top of that an inch and a half of poured lead joint and drove it up. In three miles, the 36-inch pipe carrying two million cubic feet of gas under 10 pounds pressure, the joints we have had to redrive have been so negligible that we have not kept any record of them. On the first line, with the same joints, we spent more in redriving leaks than it cost us to lay the original line. That looks like a complicated joint, but it did make a big difference.

Mr. W. C. Hawley:[3] Perhaps the convention will be interested in a test we made the other day of a line of 6 inch pipe 7800 feet long we laid with leadite early last fall, but which we did not test until just before cold weather. The test was not satisfactory. The joints had all been tested in the trench, but there was evidence of too much leakage. Probably they did not get the curb tap turned right or something, but we retested that line about three weeks ago, and the first seven minutes the meter registered two-hundredths of a cubic foot and in the next ten minutes, six-hundredths of a cubic foot. That rate of registration is probably too small to indicate

[6] Superintendent, Central Water Works, Ensley, Ala.

satisfactory results, that is, I mean the meter can hardly be expected to register accurately at such a low rate, but at any rate the leakage is very small in about 7800 feet of 6-inch pipe.

Mr. H. F. Cox:[7] I should like to add our testimony. In Scranton we have the same trouble. Our Wilkesbarre people have been using leadite three or four years. We made a visit down there to see how it was done, and it is largely a matter of skill in heating. They use common labor and we have been doing so since. Our trouble was under tracks, and we have put leadite in and have had no trouble. We have not used it under paving yet. We also had mains joined over the bridge under tracks and also ran the leadite where we could watch them. As Mr. Gibson said, we had small leaks which continued for a period of four or five weeks, but finally it all took up, so our experience with it has been very successful so far.

Mr. G. G. Dixon:[8] Like some other places, Akron had a little unfortunate experience a number of years ago with leadite, and in recent years we have never used it in practical quantities, but last year we put in about 2000 feet of 10-inch pipe in about as bad a piece of trench imaginable. It is very difficult work. It was placed in February or March. Leadite was used and no service connections were made into the main for some time after it was completed, so as to give an opportunity for testing accurately with a pressure meter. This was done, and something over 100 pounds pressure was found. The meter was read daily for a period of two weeks, during which time the leakage dropped from about 500 gallons per day per mile of pipe to about 250. Our standard of leakage in those times was about 200. The meter was then read again about a week and a half later, and the leakage had by that time dropped a little below our standard of 200. It took something between three and four weeks for the leakage in that case to drop down to our standard.

Mr. J. A. Jensen:[9] You may be interested in our experience in Minneapolis. We had a section cut off temporarily and there was laid on the top of the ground a 6-inch main. Some people interested in substitutes for lead asked for an opportunity to make a demon-

[7] Chief Engineer, Scranton Gas and Water Company, Scranton, Pa.
[8] Chief Engineer, Bureau Water Works Improvement, Akron, Ohio.
[9] Supervisor, Water Works Department, Minneapolis, Minn.

stration and we thought we would give them a chance on this line. They did not get on the job right away, so we started to make lead joints and they finally came out and finished the job with substitute. The line was in service for 90 days, and they made the joints themselves according to the usual practice with a high gait. At the end of 90 days, when we were ready to take the pipe out, we made an inspection, and I might say that, out of the 45 or 50 joints that were made, there were only about 2 that you could call passable. There was a great deal of leakage, but all of the lead joints were dry. Where we laid the pipe 8 feet below the grade of the street, we might hesitate about taking any other material as a substitute for lead. The joint is the weakest point in the pipe line, and, therefore, we would hesitate naturally about using something that might be inferior. We figured out that, of the total cost of a line of 12-inch pipe, the cost was about 2 per cent more by using lead, and we felt that that was might cheap insurance.

Mr. S. H. Taylor:[10] Perhaps I should give you the benefit of New Bedford's experience in lead pipe. I was very skeptical and thought I was going to avoid using it by proving it to be no good. About 15 years ago there were a few joints made experimentally in New Bedford and covered up. As is usual with leadite, the first week or so produced a little water, but it tightened right up and has given no trouble since. About 3 years ago we were about to do considerable work, about a mile and a half of 36-inch, and are now doing nearly 4 miles at Wauhegon. Of course the leadite men were around and we agreed to make a test. We put six pipes together, 3 with leadite and 3 with another substance, and put them up to 200 pounds pressure with no disastrous result. Then we started to pick up the two ends with a derrick so that we got the pipe practically suspended by the ends. I was much surprised at the elasticity of the material, for only one joint broke, which was not leadite. Then we laid the end on the ground and caulked up that break with lead and the six lengths of pipe lay in the yard for a month, absolutely tight. Since then, for the past 3 years, we have used leadite almost exclusively with very good results. I recall only one or two cases in many miles of pipe where it was used that we had to make a joint afterwards. We have laid in that time probably 7 or 8 miles of

[10] Assistant Superintendent, Water Works, New Bedford, Mass.

ordinary size pipe 6 to 12 inches, and over a mile of 36-inch and over a mile of 48-inch pipe. We are now laying more 48-inch and we are so well satisfied with the leadite that we are sticking right to it. We show a saving in our 48-inch joints of about 75 per cent, without taking any account of the difference in the bell hold, that is, simply on material and labor. It requires about 3 men to make a leadite joint in 10 minutes, and the same 3 men would take an hour and forty minutes to make a lead joint. That, in addition to the cost of the material, makes a difference of about 75 per cent and the saving in bell holds is additional to that.

PROBLEMS IN THE REFORESTATION OF WATERSHEDS[1]

By George R. Taylor[2]

The American Waterworks Association is meeting here in Penn's Woods, that boundless domain, whose inexhaustible forests should have produced timber sufficient for countless generations. For years Pennsylvania led all states in the production of lumber. Even in 1900 we were producing enough timber to build houses for our people. Today we have passed from a living to a dead state. We are producing only enough lumber to make coffins to bury our people. Worse than that, we are cutting our remaining supplies much faster than we are growing them. In another decade we will have to depend on outside sources for even our coffins.

This same story may be told of practically every state east of the Rockies and north of the Mason and Dixon's Line. Even the South has reached the point where she can begin to count her remaining years of timber production. But it is unnecessary to go further into the question of our timber supplies. We are all agreed that a serious situation faces us and that the problem of reforesting our wild lands must be solved. The question is: "Who is to do it and how is it to be done."

Unquestionably the national and state governments should lead the way both in the experimental and the practical side of reforestation. Mr. Gifford Pinchot, our former State Commissioner of Forestry, tells us that there are 5,000,000 acres in what he has aptly termed "The Great Pennsylvania Desert." This area, he believes, should be owned by the State and developed into a system of state forests. Similar deserts exist in most of our eastern states and should be under state control. Yet with our state forestry departments working at full capacity, there would still remain much to be done. Little can be expected of the private owner, because few are willing to spend time, money and labor in a cause whose benefits are to be reaped by second and third generations. Only corporations having a

[1] Presented before the Philadelphia Convention, May 17, 1922.

[2] Chemist and Bacteriologist, Scranton Gas and Water Co., Scranton, Pa.

continuity of existence sufficient to cover the sixty to one hundred years necessary to grow virgin timber, may be reasonably expected to make any real effort toward reforestation. Among such corporations there is none to whom forestry work should make a stronger appeal than our waterworks organizations, either privately or municipally controlled. There are numerous reasons why waterworks plants are particularly favorably situated for reforestation. They are frequently large owners of land which naturally has but few uses. They are interested in the run-off from the catchment area, the peaks of flood and the depths of drouth, the turbidity of the streams and the sanitary quality of the water; all of which would be more or less favorably influenced were the watershed largely covered with forests. It is clear that waterworks plants are vitally interested in reforestation. The problem then remains of how to get it done.

Safety is the prime necessity in forest work and its synonym is fire protection. We have 5,000,000 acres in our Great Pennsylvania Desert because of forest fire, that curse of the forest which has turned our former woodlands into barren, desolate tracts. The first step in combating the forest fire evil in an efficient state forest fire system, with district fire wardens covering the entire state. Each district should have its fire towers and watchmen. The district warden should have authority and money to secure men to fight forest fires. Such a state-wide system is needed, if forest fire damage is to be reduced to a minimum. To supplement state effort, there should be effective work by the individual owner. In Pennsylvania, the State Department began a thorough state-wide fight against forest fires in 1920. This year, in the Scranton district, we have a district warden and 150 fire wardens to cover the 2264 miles.

Our own experience in fire protection covers twenty years of work, during 18 years of which we were absolutely alone in our efforts, receiving no help from either state or private owners. This fact must be borne in mind, as it has had much to do with the thoroughness of our preparations and the costs of our fire fighting service. We hold 19,000 acres of land scattered over three counties in Northeastern Pennsylvania. About 7000 acres are in a solid tract, 6 miles long and 2 wide, adjoining the City of Scranton and in part within the City limits. This area is readily accessible from the City by various public roads and the 16 miles of our own macadam road which we maintain upon it. It is, in fact, a great public park through

which thousands of people pass on holidays and Sundays. Because of these conditions fires are numerous and we are forced to maintain a constant vigilant watch. In the center of the tract we have a large farm, where some 20 men are variously employed by us in farm work, road maintenance, sawmill and forest work, general watershed care and work on the city system. A watchman is kept on our fire tower and the men are always ready to drop their tools and rush to a reported fire. On Sundays and holidays they are kept in waiting, reenforced by an automobile truck to carry them rapidly over the territory. The district is roughly bisected by a road running through the entire tract and is further cut up by our own road system. It is divided into smaller blocks by our fire and land lines, which total about 20 miles in length. The care of these fire lines, watching for fires, and fire fighting have meant an annual expenditure of about 60 cents per acre for the entire tract. This is very high, but it has been made necessary because of the extreme fire hazard which we have to face. With all this care, 400 acres, or 6 per cent of the entire tract, have been burned over in the past ten years. In contrast to this we have 3000 acres on the head of our main stream, in a thinly settled region, where our only expense is to fight an occasional fire which starts from the railroad. Or again, a tract of about 1000 acres in a thickly settled farming district where fires are practically unknown and nothing is spent on fire protection. We feel that the activity of the State Forestry Department, in the near future, will materially lessen these high costs, as well as furnish more thorough protection.

In actual fire fighting men are equipped with four gallon galvanized iron canteens for carrying water which are strapped to their backs, chemical extinguishers, iron rakes, pails and so forth. Our main reliance is placed on beating the fire out by the use of water and evergreen boughs. It should be understood that we refer to surface fires in the low brush growing on our mountains, not of big timber fires. We fall back on our fire lines for back firing as a last resort, in case of high wind or rapid progress of the fire. The maintenance of fire lines is a problem in itself. Probably a fire line should be looked upon merely as a line from which to back fire. From this standpoint it might be a line 2 feet wide from which all top soil has been removed to make the line absolutely devoid of vegetation. On the other hand, a 20-foot line is more satisfactory in many ways. If a fire line is to be regarded as a line on which to hold a fire, a 20-foot

line is more successful than the narrower one. In such a line the removal of the timber is follwed by a growth of sprouts, weeds, and brush which is more dangerous than the original stand. Mowing and burning every fall will keep the fire line in fairly good shape, but is attended with some hazard and encourages the growth of weeds. One method of removing this second growth is by grubbing the line with pick axes, removing the smaller sprouts by the roots and burning the line. This is expensive, as grubbing will cost from 30 to 40 cents a square yard. Furthermore, it is not complete and repeated grubbings are necessary before the line becomes a barren waste.

We have experimented with chemicals in killing the vegetation on our fire lines. Most chemicals, however, as they are washed out of the soil by rain, seem to stimulate the growth of weeds. We have used gas tar on our fire lines with a considerable degree of success. Gas tar, a residue from our gas works, is a thin sticky fluid, pours readily, is noninflammable at ordinary forest fire temperatures, is not readily washed out of the soil by rains and is very toxic to vegetation. We have applied this by hand, using sprinkling pots. It requires 1 to 2 gallons per square yard of fire line to be effective in killing vegetation. Just how long the tar will last we cannot say, but our lines after two or three summers are holding in good shape. We have not as yet put gas tar on a line where the only preparation had been to cut and burn the trees and brush. The quantity of tar would have to be increased, but we have no doubt that the results would be equally good, as the tar will kill sprouts of a year's growth. Gas tar is a by-product in water gas manufacture and may be sold for 5 cents per gallon. This is of tar of not more than 3 per cent water content. The tar as we have generally used it contains up to 25 per cent water which aids in pouring it, but decreases its toxic effect. We figure that it costs us from 10 to 15 cents per square yard to apply gas tar so as to form an effective fire line.

Where coniferous timber is removed there is left in the top layers of soil sufficient seed to insure natural regeneration of the forest. With hard wood the same results is effected by sprouts from the roots. The first fire on this tract destroys the seed and sprouts, successive fires burn out the top soil, until finally we have the barren tracts so common in our Pennsylvania mountains where only fire cherry, birch and poplar grow. In such lands artificial regeneration is an absolute necessity. Further than that, if one wishes to control the type of tree growth, it can only be done by planting. Then natural

regeneration on lands which have been scarred by fire, even if very slightly, is extremely slow. The species of trees which should be planted are, first of all, those which are native to your particular section. In addition, experimental planting should be made of various other trees which may seem desirable. Planting should not be confined to a single species any more than you should put all your eggs into one basket. Consideration should be given also to future utilization of the timber. A water system can make more use of the soft woods than of the hard. With us the prevailing types of trees are the hard woods, such as maple, oak, beech and birch, so there has been no necessity to plant them. In selecting a species for a given tract, consideration must be given to the nature of the ground, swampy or dry, sheltered or exposed, whether open or covered with undergrowth, type of soil, and various other factors.

The following table will give the habitats of the principal soft woods of the eastern section.

SPECIES	SOIL	SHADE
White pine, P. Strobus	Moist to moderately dry	Very tolerant
Pitch pine, P. Rigida	Drier soils	Will stand some shade
Red pine, P. Resinosa	Moist to dry soil	Will stand some shade
Norway spruce, Picea Abies	Moist to swampy soil	Intolerant of shade
European larch, Larixdecidua	Gravelly soils	Intolerant of shade
Scotch pine, P. Sylvestris	Anything except swamp	Intolerant of shade
Austrian pine, P. Laricio	Dry to moist soils	Intolerant of shade

If you are fortunate enough to have old fields available for planting you may put in almost any species you wish and get satisfactory results. If you are planting old fire burns covered with sweet fern, briers, tangles of scrub oak and groves of poplar, fire cherry and gray birch with an occasional oak or maple thrusting its green crown up above the tangle to belie its fire-scarred trunk, you are practically limited to white pine on the drier tracts and either white pine or Norway spruce in the wetter locations. We have been trying pitch pine, P. Rigida, in places of moderate shade, but we have not had enough years of experience to determine how satisfactory it is going to be. White pine and Norway spruce are shade loving and will eventually find their way up through scrub oak and other low growing

bushes. The trees obtained for planting are seedlings from one to three years old and 4 to 10 inches in height. They may be bought from private nurseries, as our earlier plantings were. Of recent years the Pennsylvania Department of Forestry has furnished forest trees free to planters, making a charge to cover the cost of digging, packing and transportation. A number of other state forestry departments are doing the same thing and it is an activity which waterworks people should urge in all states. Pennsylvania this year is sending out 4,000,000 seedlings, next year they expect 6,000,000, and in 1924 and thereafter they expect to have 20,000,000. The trees are bunched in fifties, boxed and shipped by express. Immediately upon receipt they should be inspected and "heeled in" in the ground. "To heel in," a furrow about 4 inches deep should be plowed in good soil which is reasonably free from stone. The bunches should be put in this furrow and the dirt packed back about the roots covering the stems in part. The row should not be more than two bunches wide to avoid heating. If the ground is partially shaded so much the better. "Heeled in" in this way trees may be kept in perfect safety for two weeks, during March and April.

We plant the trees from four to six feet apart, generally about four feet. The latter distance means 2700 trees to the acre, while six feet provides 1200 trees per acre. We make the holes with broad-bladed picks, known as mattocks. Following the pick men come the droppers carrying the trees in pails having a little water in them to keep the trees moist. One man will drop for two to three rows of pick men. Behind these come the men who actually plant the trees, one man to each row. The planting is very simple. Just stick the tree in the hole and scrape the dirt back in with the hand, a scraper or as some or our men seem to prefer, a small stone. This stone is then used to pack the dirt around the tree by striking the ground with it. Another way to firm the tree in is to step on the dirt that has been thrown back into the hole. This firming in process is very essential in tree planting. The imperative precaution to be taken in handling is the same as that for transplanting all trees—do not let the roots dry out. Bunches must not be left around to be exposed to the sun or air. The work should be so handled that those covering the trees keep well up with those dropping them. To mark the planting line the outside line of holes should be left unplanted on each trip across the piece of land being planted. If the planting site is at a distance from the place where they are heeled in, enough trees

for the day's work should be brought up and heeled in at a convenient spot.

In old mowing land, where the land is smooth, it may be advantageous to plow shallow furrows to facilitate planting, although we have always preferred hand planting. Where the ground is favorable a force of men will put in 1200 to 1500 trees per man a day. In wild land covered with scrub oak and briers, the average may drop to 500 trees a day. The total cost of the trees in the ground, including the department charges for digging, expressage, and our labor for planting, will run from three to five dollars per 1000 trees.

Trees should be planted as early in the spring as the ground is workable. Trees planted in March and early April do very much better than those set in May, as the earlier trees get rooted before the hot weather of July scorches them. Many failures are traceable to late planting and even where they survive they remain in a stunted condition for some years before making a start. After planting little need be done for the trees, except to keep out fires. In later years, questions arise of thinning and utilization of the smaller trees in the tract which are being overgrown. These question have not come up with us as yet. One method of planting which has been tried in some instances is to plant the alternate rows to evergreens suitable for Christmas trees. In a few years these could be removed and sold, thus giving an early income from the area. The feasibility of this is debatable and we have never practised it. The mixed planting of trees has certain advantages over planting in pure stands. One important thing is that it tends to cut down damage due to disease.

We began our planting in 1912, putting out 80,000 white pine. We continued planting pine at intervals until 1918, when we began experimental plantings of different species. We have now put in 985,000 trees, of which 513,000 are white pine. We have tried Scotch pine, red pine, pitch pine, European larch, Norway spruce, white ash and black walnut. Our results have been somewhat varied in character. Some have been unqualified successes, others are as yet uncertain. By far the greater part of our trees have lived, although in some instances the growth has been very slow. Scotch pine has not grown very rapidly with us, contrary to general experience. Our pitch pine plantings have been too recent to form any definite idea, but, as it is a local tree, there is no reason why it should not succeed, if the particular site is favorable. European larch has been a complete failure with us, both in growth and in withstanding our

severe winters. One planting has only 5 per cent of the trees living; another under different soil and exposure conditions has 40 per cent living; while a third is somewhat between the two. Norway spruce has given us 90 per cent living, but the seedlings do not grow. Some that were set out in 1918 have not grown more than 6 inches in that time. White ash was a complete failure as was also the planting of black walnut nuts. Red pine has been a great success so far. Practically 100 per cent of the trees have lived and the growth has been very satisfactory. We find, however, that they are very intolerant of shade. In one field there is a large patch of sweet fern covering nearly an acre. The red pine will not come up through this, either dying or standing still without making any growth. We plan to use red pine and pitch pine in the near future wherever possible. Yet, because of scrub growth already existing, probably 90 per cent of our land either must be planted to white pine or allowed to go through the slow and frequently unsatisfactory process of natural regeneration. Pitch pine and red pine are moderately resistant to fire, owing to the large amount of pitch in the bark. Pitch pine, in particular, will live through surface fires which kill all other trees.

The problems of tree diseases are becoming more and more pressing every year. We are only too familiar with the ravages of the chestnut blight and the resultant wiping out of the chestnut tree. The various scales attack some of our forest trees causing considerable damage. White ash is particularly affected by it and in our own section ash sprouts are being killed by scale to an alarming degree, if you consider the relative scarcity of these trees and their high value for lumber. White pine is attacked by the weevil, occasionally to such an extent as practically to destroy a plantation. The weevil is a white grub which bores the path of the leader, killing it. The tree is thus forced to make one of the lateral branches into a leader, in this way producing a crook. Usually the infection is not heavy enough to cause any more serious damage than this. The ravages of the gypsy and brown tail moths in New England are well known. All of those except the weevil were imported. The most serious importation of all is the white pine blister rust, which was brought into New England on imported white pine seedling, some twenty years ago. The disease has spread slowly over the north, until it is pretty well distributed over the white pine territory and threatens to wipe out the white pine tree as the chestnut blight has the chestnut.

White pine blister rust is an infection of the inner bark of young branches of white pines, which slowly travels down the trunk and eventually kills the tree. The life cycle of the rust is in three stages, the first two stages of which are passed on white pine, while the third stage is passed on members of the ribes family, i.e., currant and gooseberries, either wild or cultivated. Its first stage on the pine is the dormant stage, which lasts from two to four years before passing into the second or active stage. In this stage the bark is killed in the center of the infection, while toward the outer portion of the infection spores are produced. At the extreme edge mycelium threads extend the disease farther down the limb into the trunk bark. When the infection reaches the trunk the killing of the whole tree takes place rather slowly. The spores produced in the active stage on the pine can only grow on leaves of members of the ribes family, i.e., currants and gooseberries. In this third stage on ribes, spores are produced which will develop only on members of the five needled group of pines, the principal of which is white pine. Here it begins its life history over again. It is evident, therefore, that this rust will develop and spread only in those sections where both white pine and ribes are present. It is desirable, therefore, to growth either one of the two in a given district, but not both. An infected white pine does not directly infect the white pine which stands beside it, but the spores must pass from the diseased tree to some currant bush. New spores must be formed and these pass back to the sound pine tree. The spores which are formed on the pine tree are of high vitality and may be transmitted over long distances by the wind, animals, birds, moving vehicles and other agencies. The spores which are formed on the ribes plant are frail and of low vitality so they are carried only relatively short distances. We find, therefore, rather unexpectedly, perhaps, that currants and gooseberries are becoming infected over wide areas which were supposed to be free from the disease, but that the infection of the white pines is taking place more slowly and over more limited areas. One to six hundred yards may be set as the limiting distances over which infection of the pines from diseased ribes may take place, with 200 yards representing the maximum, except under extremely favorable conditions. It will be seen that we are not facing whosesale slaughter of the pines, as was the case with the chestnut tree. The fact that the disease does not spread from tree to tree makes its progress slower and furthermore makes the possibility of its control much more certain. Control of the white pine blister seems possible through extermination of all

gooseberries and currants which are within two hundred yards of a given stand of white pines. At first thought this may seem prohibitive in cost, but work, which has been done in New England and New York would indicate that on many tracts the costs are very reasonable. We have not as yet done any work on removing ribes. We expect to send out inspection parties this summer to determine how numerous ribes are and to get some idea of the cost of digging them out. One may naturally ask why plant white pine at all under these conditions. There are several reasons why we should continue to plant white pine, if there is any possible chance of success. First, there is no tree which produces timber of the quality of white pine. Second, white pine will thrive under a greater variety of condition as to soil and moisture than most other trees. Third, no other soft wood, except spruce, can be planted in thick growths such as birch, poplar and scrub oak, with any assistance of the plantation growing up through the scrub. In our opinion there is no tree possessing the merits of white pine for general forest planting and we are loath to give it up without a struggle. As to substitutes, there are none. Red pine seems the most satisfactory one to try. It is hardy, a rapid grower, makes good lumber, is not subject to any known disease but has the fatal defect, for us at any rate, that it cannot be depended upon to come up through growth of underbrush. Its use must be restricted to fairly open ground. In this respect it is similar to Scotch and Austrian pine and the larches. The spruces will endure shade but are not very satisfactory for planting in the drier soils.

Tree diseases have made more complicated the problems of natural regeneration, as well as those of planting. They have brought up also the question of the utilization of the dead and dying trees in the already existing stands.

We are operating a small portable sawmill, utilizing first of all the dead chestnut and other timber and, in addition, taking out mature specimens of all trees for which we have use. We saw our own rough construction material, together with such specialties as pipe blocks, stone boat, ties, wagon poles, fence posts and a variety of plank and timber. Much of this utilization work has been a direct result of the ravages of the chestnut tree blight. A considerable quantity has been sold as mine props, either on the stump or at the mine. Our own cuttings have been carried out in as careful a manner as possible. All brush has been burned and, in many cases, the small chestnut sprouts have been removed to lessen the fire hazard and improve the general condition of the woods. We are sawing about

75,000 board feet of lumber every winter and 10,000 to 15,000 pipe blocks. Fire wood, except high grade fire place wood, has no value in the anthracite region, so everything below log size must be burned. The cost of operation is necessarily high, as we are picking the cut out of the general forest growth. However, we have been able to produce lumber at approximately local cost price when engaged on straight lumbering work. We feel further that we have done a valuable work by removing dead and dying timber which was rapidly becoming a serious fire menace. Another factor to be considered here is the constant employment furnished the men. This is of great value in lessening seasonal unemployment.

We believe that the reforestation of our watersheds has sufficient merit to be adopted by every member of the American Waterworks Association. Further, the Association should help this work by urging upon our various state forestry departments the adoption of broad and liberal policies, looking toward the reforestation of all our waste lands. The Association should stand behind all agencies which are endeavoring to restrict the spread of tree diseases by quarantine and inspection of shipments and, if necessary, by the enforced removal of plants which may act as hosts. It is worthy of note that the gypsy moth, the chestnut blight, the white pine blister rust, and other tree diseases were imported prior to the federal law prohibiting the importation of trees and shrubs except under special authorization. Had this law been in force twenty-five years ago we might have been spared at least some of the enemies listed.

In summary, it should be stated that fire protection is the Alpha and Omega of reforestation. Without it all attempts are useless. Those varieties should be planted which are native to your section and which will furnish the lumber you desire. Experiment with such other varieties as give promise of success. Keep a constant watch for tree diseases. Cooperate in every way with the various state and national agencies who are endeavoring to combat, by quarantines and various wars of extermination, the microscopic enemies of forest life. Utilize the existing timber which you already have.

Finally, regard reforestation as a necessary waterworks policy, not merely because of its possible economic value, but on the broader grounds of sanitary control, greater stability of run-off and conservation of the timber resources of the nation. We should feel it a duty to recreate "Penn's Woods" that our children's children may derive their water supplies, in part at least, from the fair green forests of our forefathers.

CHLORINATION TASTES AND ODORS[1]

By Wellington Donaldson[2]

Following the court decree of May, 1910, in the well known Jersey City case, which was generally regarded as establishing the legitimacy of chlorination as a method of water treatment, in so far as concerned American practice, hypochlorite plants began to be installed for certain supplies experiencing difficulty in conforming to accepted standards for bacterial purity. By 1912 or 1913 the practice of sterilization by hypochlorite had become generally established. Later the marketing of successful apparatus for feeding liquid chlorine or chlorine gas gave great impetus to chlorination treatment, resulting in the displacement of many hypochlorite installations by liquid chlorine apparatus and extending marvelously the utility of this treatment both for permanent installations and for emergency and portable use. The outstanding example of the latter is the service with the various armies in the Great War. Whether or not one agrees with the dictum that no "water supply is safe without chlorination"—and the writer personally finds some objection to that phrase—it cannot be disputed that unchlorinated water supplies derived from surface sources are much in the minority in the United States at the present time. The marked decline in typhoid incidence and mortality in the principal urban communities testifies strongly to the wisdom of the practice.

Concurrent with the general adoption of chlorination there began to be noted an annoying prevalence of tastes and odors in many supplies so treated. During the ensuing decade, 1912-1922, a great deal has been done towards eliminating tastes and odors, although unfortunatly at the present time complaints are not infrequent even with some of the larger water supplies kept under close technical supervision. Many of the troubles of the earlier hypochlorite installations were unquestionably due to lack of adequate devices for

[1] Read before Chemical and Bacteriological Section, Philadelphia Convention, May 19, 1922.

[2] With Fuller and McClintock, New York, N. Y.

feeding the solution at a uniform rate or in proportion to the water treated, to the failure to determine on a routine basis the actual strength of the chemical, or to the failure to make tests for residual chlorine on the treated water. There are today numerous hypochlorite installations 8, 10 or even 12 years old, in daily service with satisfactory results both as to sterilization and comparative freedom from tastes and odors, but the considerable supplanting of the older method by liquid chlorine has undoubtedly resulted in elimination of much taste complaint, by reason of the obvious advantages of liquid chlorine in the way of close regulation, uniform strength of chemical, ease of adjustment, etc. Even so, it is by no means rare to find liquid chlorine installations where proper attention is not given to making the doses follow closely the variations in water flow and the variations in quality of the water treated. It is not surprising, then, that such installations give trouble occasionally on account of overdosing.

It is a necessary preliminary to any study of tastes and odors to ascertain if the taste and odor are absent from the unchlorinated water. If taste and odor are found only in the chlorinated water, their occurrence may be attributed to one or more of the following causes:

a. Excess or "free" chlorine.

b. Substitution compounds of chlorine with organic substances.

c. Killing of organisms with subsequent liberation of aromatic substances, which may or may not unite with chlorine.

With filtration plants delivering directly into the distribution system the last factor may be eliminated.

The taste of chlorine itself, if present in considerable excess, is easy to recognize by comparing with very weak solutions of chlorine or bleach. In the writer's experience 0.4 ppm., shown as "residual" chlorine, is about the limit of the average person's ability to taste pure chlorine, though some persons with sensitive taste can detect a lesser amount.

The absence of taste after boiling has been suggested as a means of differentiating free chlorine from its substitution compounds, but is not entirely reliable, as some substitution products are largely removed by a few minutes boiling. The addition of an "anti-chlor" such as sodium thiosulphate, to the sample before testing has been found useful in deciding as to the possibility of free chlorine being a factor. In connection with the possibility of excess chlorine the

"chlorine absorption" value advocated by Race, Wolman and others (1, 2, 6, 7) will be found useful. Many water purification plants control chlorine feeding on the basis of maintaining a fixed "residual" chlorine of 0.1 to 0.3 ppm. in the effluent, the desired amount being determined by experience for that particular supply. The Wolman method, by reason of establishing a standard dose and a standard contact period, has the value of an exact laboratory expression, which makes all results comparable, but the writer prefers for practical plant operation the second method, which involves only a simple color text with o-tolidin and the matching against bottle standards (the writer uses 4-oz. oil sample bottles, E. & A. no. 1062, in preference to Nessler tubes)

It is usually the case that odors and tastes are much more pronounced at points on the distribution system than at the purification plant, and it is rare that tests for residual chlorine can be gotten from the consumer's faucet, by reason of rapid dissipation of the chlorine in contact with the surface of iron pipe.

If the chlorinated water gives no test for residual chlorine but has a disagreeable taste, it seems prima facie evidence that the trouble is due to "substitution" compounds, meaning thereby a combination of chlorine with some organic constituent of the water. Since the early days of chlorination there has been recognized the probability of organic matter combining with chlorine and thus giving rise to disagreeable tastes. The term "organic matter" as applied to water is a very broad term which includes many substances of whose nature we have little specific knowledge and at present little means of differentiating by laboratory tests.

The responsibility of humus substances from decaying vegetation for production of tastes and odors after chlorination is not very well defined. There are numerous examples of well-managed water supplies located on streams known not to receive any industrial wastes, yet troubled with chlorination tastes and odors. The correlation between the oxygen absorbed tests and the chlorine requirement has been fairly well established, but information is lacking as to the effect of high organic matter on production of taste after chlorination. In fact, those supplies with very low organic content seem to experience the greatest trouble.

In regard to the effect of algae on production of tastes and odors the symposium recently conducted by the Engineering News-Record (8) developed a lack of information bearing on this phase. The

writer believes that algae frequently are responsible for mild chlorination taste and recalls an instance where Lyngbya, one of the blue-green algae, when allowed to collect in quantities on the filter beds, gave rise to an unpleasant taste in the water after chlorination. The taste was quite perceptible at the plant, though no complaints were reported by consumers. On the other hand, the writer has chlorinated an unfiltered supply heavily infested with diatoms (Cyclotella, principally) without appreciably altering the distinct "woody" taste present in the unchlorinated water.

The effect of protozoa on production of taste after chlorination, is fresh in the mind in connection with recent experiences of the New York Water Department reported by Brush (12) in dealing with synura in company with certain diatoms. The remarkable feature of the New York experience was the discovery that while the usual dose of chlorine accentuated the taste and odor from synura an increased dose eliminated the trouble. The same phenomenon had been previously reported by Girvan (4) and Houston (5) in connection with the New River supply of the London Metropolitan District.

The increasing pollution of our streams and waterways by industrial wastes has brought to light within the last three years another class of organic substances which affect very greatly the tastes and odors of chlorinated supplies. Principal offenders are the coke byproducts plants, city gas plants, producer gas plants and similar industries which discharge spent still liquors or even crude tars. The wastes from coal distillation contain phenol itself, but usually its homologs, such as the cresols, predominate. All of these substances exhibit a marked tendency to form "substitution" compounds with chlorine even in extremely high dilutions, resulting in an obnoxious medicinal taste in water supplies. The taste and odor are greatly intensified by heat.

Abundant instances are at hand bearing on the subject. The Milwaukee experiences with obnoxious tastes in its water supply were very clearly traced to the operation of certain coal distillation plants discharging wastes into the river and the lake (3). The writer has previously recorded (10) an experience with freshly dipped cast iron pipe. Hechmer (11) has presented evidence of the same trouble from use of freshly applied coal tar paint to an elevated water tank. Rowe (13) has naively and most interestingly reported an experience with pipe coating. The evidence is conclusive that the

presence of phenols in water results, after chlorination, in greatly intensified and disagreeable tastes and odors. The numerous sources of phenol pollution to our streams makes the situation from the waterworks standpoint quite serious. So widespread is the trouble from this source that the writer is tempted to say that where a water supply experiences disagreeable "medicinal" tastes after chlorination, and tests show the absence of "free" or "residual" chlorine, then the trouble is apt to be due to the presence in the supply of phenols which may be detected and measured by suitable methods discussed below.

One of the simplest tests for phenol is that largely used in the Milwaukee investigation, namely, of simply adding to the suspected water a few drops of bleach solution and noting if the intense substitution taste occurs, particularly after warming. Such a test may not detect very minute traces of phenol, which however may affect the water supply. Usually some concentration method is necessary. In some early investigations at New Castle, Pa. the writer used successfully a method furnished by Prof. Aschmann of Pittsburgh, namely, skaking with ether in a separatory funnel, allowing the ether portion to evaporate and noting the residual odor. Adding to the residue a few cc. of distilled water and a drop of bromine water results in a turbidity or white precipitate of tri-bromphenol in the presence of appreciable quantities of phenol.

Shaking large volumes of water (1 to 20 liters) with chloroform and evaporating the settled chloroform in a covered dish was found simpler and more sensitive then the foregoing. Addition of a few drops of bleach solution just after the chloroform evaporated produced the characteristic medicinal tri-chloro-phenol odor.

In the New Castle investigations referred to interesting results were gotten by freezing, at one of the local ice plants, 400 pound cakes from the city water, which had at that time a disagreeable medicinal taste. It was found that the cores of the cakes had a pronounced and unmistakable odor and taste of cresol. The engineer of the ice-plant promptly called it a "lysol" odor, which is quite descriptive. On melting the core ice the cresol odor disappeared and was replaced by a strong woody odor.

The simple qualitative tests mentioned, though useful in helping decide the nature of the polluting substances, have little or no value for quantitative study. E. P. Fager, then chemist of the water company at South Pittsburgh, Pa., in studying in 1919 a variety of methods, with a view of quantitative estimation, devised a modification of the Folin-Denis reagent suitable for estimation of phenols

in water. The method with slight modification was later used in the New Castle investigation in the winter of 1919–20. Following Scott's publication of the method (14), successful results from the method have been reported from a number of laboratories. The Folin-Denis reagent is quite sensitive to phenols (about 0.1 ppm. without distillation) although responsive also to quite a number of other substances, as various observers have noted. The different color reactions, varying from blue to green, are not without value in distinguishing phenol from some of its homologs. The reagent responds also to the higher phenols from the wood distillation industry.

It may be interesting to record here the findings at the New Castle plant that water containing 0.3 ppm. phenol gave rise to noticeable taste after chlorination, which agrees closely with the 0.2 ppm. reported by Ellms and Lawrence (9) as a result of dilution experiments.

In connection with the trouble by some laboratories in getting distilled water blanks for this reagent the writer calls attention to the fact that distilled water prepared from a water supply containing phenols will certainly contain phenol also. Repeated distillation will not eliminate phenol unless a batch still is used and first portions, containing the bulk of phenols, discarded. The writer has found it much simpler to procure distilled water from a spring or other supply not contaminated with phenols.

Another sensitive quantitative test for phenols in water has been proposed by Fox and Gauge (17), based on the diazo reaction familiar to the organic chemist. Apparently this was used in connection with investigations of the Joint Fisheries Committee in England, as no mention was made of its use in connection with public water supplies. To save the trouble of referring to the English journal in which the article was published the following brief abstract is given:

> Place 100 cc. of sample in a Nessler jar; add 5 cc. sodium hydroxide (8 per cent); add 10 per cent diazotized sulphanilic acid.[3] On stirring, an orange color is formed when tar acids are present.

Distilling 250 to 500 cc. of sample is advised if the sample contains turbidity. The author claims a sensitiveness of less than 1 ppm.

[3] The diazotized sulphanilic acid is prepared 5 minutes before use by mixing 5 volumes of sulphanilic acid (1.91 grams in 250 cc. of distilled water) with one volume sulphuric acid (1 to 3), adding 5 volumes sodium nitrite (0.85 gram in 250 cc. distilled water) and cooling in a stream of cold water.

in comparing with standards prepared by mixing the three cresols in stated proportions. Other observers report a sensitiveness of 0.1 ppm. to pure phenol.

In connection with quantitative determinations of phenols in water, the writer suggests that pure phenol, C_6H_5OH, be used as the standard expression for the analysis, whether the actual substance under test be phenol, cresol, guaiacol or some other phenolic substance. Such expression is comparable with the expression of alkalinity, incrustants and hardness in terms of calcium carbonate.

RECENT BIBLIOGRAPHY

(1) Race, Joseph: Chlorination of Water, Wiley & Sons, 1918.

(2) Wolman, A., and Enslow, L. H.: Chlorine absorption and the chlorination of water. J. Ind. & Eng. Chem. (1919) **11**, 209.

(3) Bohmann, H. P.: Find cause of obnoxious taste in Milwaukee water. Eng. News-Rec. (1919) **82**, 181.

(4) Girvan, A. F.: Removal of taste from chlorinated waters. Eng. & Contr. (1920) **53**, 744.

(5) Houston, A. C.: Ann. Rept., London Metropolitan Water Board, 1920.

(6) Wolman, A.: Water chlorination by the absorption method. Eng. News-Rec. (1921) **86**, 639.

(7) Sperry, W. A., and Billings, L. C.: Tastes and odors from chlorination. A. W. W. A. (1921) **8**, 603; abstracted in Eng. News-Rec. (1921) **86**, 1041.

(8) Symposium on problems in chlorination of water. Eng. News-Rec. (1921) **87**, 392, 619, 828.

(9) Ellms, J. W., and Lawrence, W. C.: The causes of obnoxious tastes and odors sometimes occurring in the Cleveland water. A. W. W. A. (1922) **9**, 463; abstracted in Eng. News-Rec. (1921) **86**, 1039.

(10) Donaldson, Wellington: Industrial wastes in relation to water supplies. Amer. Jour. Public Health (1921) **11**, 193.

(11) Hechmer, C. A.: The probable formation of phenolic compounds by a chlorinated water in contact with a coal tar paint. A. W. W. A. (1922) **9**, 319.

(12) Brush, W. W.: Synura and other organisms in Catskill water supply. Eng. News-Rec. (1922) **88**, 266.

(13) Rowe, E. J.: Chlorine tastes and odors from pipe coating. A. W. W. A. (1922) **9**, 455.

(14) Scott, R. D.: The detection of phenols in water. J. Ind. & Eng. Chem. (1921) **13**, 422. Corrections by W. Donaldson, C. E. Trowbridge and R. D. Scott. J. Ind. & Eng. Chem. (1921) **13**, 848.

(15) Chapin, Robt. M.: A new method for the determination of phenol in the presence of certain other phenols. J. Ind. & Eng. Chem. (1920) **12**, 771

(16) Chapin, Robt. M.: The diazometric determination of phenol, and certain of its homologs. J. Ind. & Eng. Chem. (1920) **12**, 568.

(17) Fox, J. J., and Gauge, J. H.: Note on the determination of tar acids in drainage from tarred roads. J. Soc. Chem. Ind. (1920) **39**, 260T.

BOUTRON BOUDET SOAP SOLUTION

By A. M. Buswell[1]

From time to time the writer has heard the question raised as to the strength of the Boutron Boudet or "B and B" soap solution and the original description of its use. Since this solution is extensively employed at the present time in specifying a water of "zero hardness," it seems worth while to give briefly its history.

Charlard Boutron and Felix Boudet (1) published an article in 1855 "Concerning hydrotimetry or a new method of analyzing water from springs and rivers." "Hydrotimetry" the authors explain is a new word which they have coined from the three Greek words "Ὕδαγ, τιμή, μέτρον" meaning a measure of the value of water. The process is essentially similar to the soap test for hardness previously described by Clark (2), with whose work Boutron and Boudet seem not to have been familiar. (From the reference it will be noted that Clark first described the soap test in his patent application of 1841 and that it was described in the Chemical Gazette by him in 1847 and abstracted in the Jahresbericht in 1850).

The authors describe their methods as follows:

> The formation of the foam on the surface of the water is moreover a phenomenon so striking, the proportion of soap necessary to produce it (1 decigram per liter) is so slight, and the moment when a calcareous or *magneseous* water ceases to neutralize soap and becomes foamy, is so easy to perceive, that a solution of soap may be considered an extremely sensitive reagent for detecting and determining the calcareous and *magneseous* salts in very dilute liquors such as spring and river waters.
>
> We employ the soap dissolved in alcohol and to avoid the errors which necessarily result from the variable composition of soap, we titrate our solution against a standard solution of fused calcium chloride containing 25 centigrams of the salt per liter of distilled water, i.e., 1 to 4000. The test is carried out in a flask of 60 to 80 cubic centimeters capacity with a ground stopper and marked at 40 cubic centimeters; and a small buret graduated in such a manner that:
>
> First, A division marked above the zero represents the amount of soap solution necessary to form a lather with 40 cubic centimeters of pure water.

---

[1] Chief, Illinois State Water Survey, Urbana, Ill.

Second, That each division below the zero degree represents 1 decigram of mottled soap of 30 to the hundred (30 per cent) of water and 6 to the hundred (6 per cent) of soda, destroyed by one liter of water subjected to the experiment and thus a water which absorbs for example 10° of the solution destroys or neutralizes 1 gram of soap per liter.

Third, Finally, that 22° corresponds exactly to 40 cubic centimeters or 40 grams of the standard solution of calcium chloride of 25 centigrams per liter.

As a result of this system the graduation of the buret indicates directly the proportion of soap destroyed by a liter of the water examined and the calcium chloride equivalent of the calcium and magnesium salts which are contained in a liter of said water. Nothing is more easy than to find out by rapid test the equivalent in calcium chloride of the salts of calcium and magnesium which waters contain and to establish their relative value by comparing the degrees which they give with the test buret. We have given this instrument the name hydrotimetre, which is to say, measure of the value of water. Our system of testing constitutes then hydrotimetry and one may classify waters according to their hydrotimetrique degrees starting from pure water which carries zero degrees.

The unit upon which the authors started out to found their method is apparently 1 decigram of "mottled soap" which is the amount required in their experiments to produce a foam with 1 liter of pure water, but realizing the variability in composition of soap they checked their soap solution against the standard $CaCl_2$ solution mentioned and the latter therefore became the real standard. Though not as clearly stated as it might be it is evident from the context that the division above the zero mark on the hydrotimeter buret has the same volume as those below, namely sufficient to hold soap solution "representing 1 decigram of mottled soap . . . . destroyed by one liter of the water tested." The standard unit is, therefore, the amount of soap required to give a lather with 40 cc. of pure water which happens to be $\frac{1}{23}$ of that required to give a lather with 40 cc. of a solution of $CaCl_2$ containing 0.25 gm. per liter.

The authors' description unfortunately defines only the $CaCl_2$ solution leaving the reader to make his own adjustment of the strength of the soap solution and the length of the buret graduations, though, of course, one depends upon the other. Zune (3) quoting Levy (4), states that the soap solution was made by dissolving 100 grams of dry almond oil soap in 1600 grams of 90 per cent alcohol and diluting with 1000 of pure water. Levy, however, used a method of standardization and calculation whereby an ordinary buret is used instead of the one described by Boutron and Boudet.

Several of the well recognized limitations of the soap test in general are cited in the same article. De la Coux (5) described what is apparently the original "hydrotimetre" which is shown in the accompanying figure. With this buret the same soap solution as that described by Levy is used. It will be seen from the figure that 2.4 cc. = 23 buret divisions. The first division, it must be remembered, measures the amount of soap required for 40 cc. of pure water. This author recommends $Ba(NO_3)_2$, instead of $CaCl_2$ for the standard

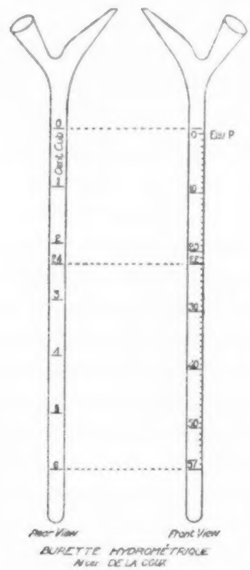


FIG. 1.

and gives 0.59 gm. per liter as the amount of $Ba(NO_3)_2$ equivalent to 0.25 gm. of $CaCl_2$.

Walter and Gärtner (6) state that the Boutron Boudet hydrotimetrique degree is the same as the French degree or one part of $CaCO_3$ per 100,000. This, however, is not the case by about 2.2 per cent. Walter and Gärtner, however, use 0.574 gm. $Ba(NO_3)_2$ per liter for their standard solution instead of 0.59, which is equivalent to the original 0.25 gm. $CaCl_2$.

Booth (7) describes the French method giving the strength of the soap solution, but not the dimensions for the buret. Booth uses the word *normal* in referring to the $CaCl_2$ and $Ba(NO_3)_2$ solutions

in the sense of *standard*, instead of in the modern colloquial chemical sense (i.e., chemical equivalents per liter).

The Boutron Boudet soap solution is then a solution of 100 grams of pure soap in about 2500 cc. of 56 per cent alcohol by volume and adjusted so that 2.4 cc. will give a lather with 40 cc. of a solution of $Ba(NO_3)_2$ containing 0.59 gm. per liter. Or, if we accept Walter and Gärtner's suggestion to make it read in "French degrees," we must use 0.574 gms $Ba(NO_3)_2$ per liter. On the basis of the relative amounts of soap used, the Boutron Boudet solution is approximately 4 to 5 times as strong as that specified by the standard methods of the A.P.H.A. Owing to the wide difference in technique, it is difficult to make a more definite comparison. Assuming that 2.4 cc. of the B and B solution equals 22 French degrees or 220 p.p.m. on a 40 cc. sample, 3.0 cc. would be required for 50 cc. We see from the table on P. 32 of Standard Methods that a solution of such a hardness would require 4.65 cc. of standard soap when diluted one to four. This comparison makes the B and B solution about six times as strong as that of standard methods. It would be about three and one-half times as strong as the solution formerly used in some laboratories, which read 1 cc. per French degree on a 100 cc. sample.

The Boutron and Boudet soap solution has a very practical value in demonstrating to the layman the value of water softening. The original unit, the amount of soap required to give a lather with pure water is something that any one can understand. It is also easily apparent that a water of 5 or 10 degrees hydrotimetrique has 5 or 10 times the soap demand of pure water.

The solution also serves a useful purpose in the hands of the non-technical owner of a zeolite water softener. He measures the performance of his machine in drops of solution, which he can understand, rather than in cubic centimeters, a unit of which he has never heard.

BIBLIOGRAPHY

(1) Boutron, Charlard et Boudet, Felix: De l'hydrotimetrique ou nouvelle methode d'analyse des eaux de sources et de rivieres. Compte Rend., **40**, 1855, p. 679.

(2) Clark, Th.: Repertory of patent inventions for 1841. A new process for purifying the water supplied to the metropolis. London, 1849.

Clark, Th.: On the examination of water for towns for its hardness. Chem. Gaz., **5**, 100, 1847. Reviewed in detail by J. Moser, Wien. Acad. Ber., 1850, April, 484; Abstract, Jahresbericht, **3**, 608, 1850.

(3) ZUNE: Traite d'Analyse des Eau Potables. Imprimerie A. Lefevre, Bruxelles, 1894.
(4) LEVY: Annuaire de l'Observatoire Municipal de Montsouris, Paris, 1892.
(5) DE LA COUX: L'Eaux dans l'Industrie, Paris, 1900.
(6) WALTER AND GÄRTNER: Tiemann-Gärtners Handbuch der Untersuchung der Wasser, 4th Ed., 1895.
(7) BOOTH: Water softening and treatment. Van Nostrand & Co., 1906.

WATER MAINS UNDER RAILROAD TRACKS[1]

Mr. D. R. Gwinn:[2] The Pennsylvania Railroad ran over some six inch pipe laid about forty years ago, and we adopted a plan, whenever we had a leak to dig up, of putting on one of those extra heavy flange sleeves made by J. B. Clow and Son. I think the flange must have been an inch and a quarter thick and a large enough sleeve to cover the bell. That seemed to be the most effective remedy we were able to use. We tried making a little tunnel on a small scale, that is, building a wall on either side and covering it over with reinforced concrete slabs. If it were of any particular length, we would fix the ends of the joints so that one would lap over the other, so the dirt would not sift through, but the best success we had was with this extra heavy sleeve. You have actually, outside of your original joint, the other two joints and you can make them as heavy as you please by pouring them solid with lead if you like.

Mr. J. E. Gibson:[3] Under railroad tracks, we have adopted the policy of laying another pipe just about the length of a cross tie, and then passing the water pipe through that and making all joints between tracks, so that if we do have a leak we can get down, as a rule, without undermining the track. If there is a breakage in the pipe passing through the outer conduits, which we have never had occasion to experience, we may substitute a new pipe without undermining the track again. This is a little more difficult but it can be done. The outside pipe simply takes the vibration off the water main, and we have found that to be very effective.

Mr. W. Luscombe:[4] We have gotten rid of a great deal of trouble with water pipes under crossings by putting the pipe under the railroad deeper than ordinarily. By placing them eight and a half to nine feet deep, we found the vibration much less and our first leak

[1] Discussion at the Philadelphia Convention, May 18, 1922.
[2] President, Water Company, Terre Haute, Indiana.
[3] Superintendent, Water Department, Charleston, S. C.
[4] Vice-President, Gary Heat, Light and Water Company, Gary, Indiana.

is yet to occur. Of course the city is rather new, but after fifteen years we have not yet had one leak under railroads. We adopt also the plan of having the joints come between the tracks so as to make them more accessible for repairs.

Mr. W. C. Hawley:[5] Twenty or twenty-five years ago an old eight inch cast iron main passed under the railroad and we had to dig down frequently to those joints and recaulk them. That was before the days of leadite. We have replaced the lead with leadite and have had no trouble since. The heavy Reading trains come in and, as they go over the thoroughfare, they put on their brakes, so that is a pretty good test of that joint.

[5] Chief Engineer and General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa.

TASTES AND ODORS[1]

Mr. H. M. Ely:[2] Danville's water supply is impounded by two dams on the North Fork of the Vermilion River. A dam at the pumping station forms the first impounding reservoir of about seventy-five million gallons capacity, in service since 1903. Another impounding reservoir is formed by a second dam located four miles up stream from the first, which has a capacity of approximately four hundred fifty million gallons. This reservoir has been in use since January, 1915.

There had been growth in the lower reservoir for some years, but never of such a character or of sufficient amount to cause any trouble. In September, 1916, a microscopical survey of both reservoirs was made by Greenfield and Mickle, of the State Water Survey. The examination showed moderate algae growth, with the microscopic flora of the reservoir rather uniform. The micro-organisms found at that time were protozoan forms, rotifers, chlorophyceae; crustaceans rather numerous; protococcus most numerous; euglena in small numbers. A second microscopical survey was made by the same persons in July, 1917, which showed the microscopic flora not materially different from that of the first survey. The organisms present at that time were diatoms, protocola, rotifers and crustaceans, in addition to the algae forms, with no euglena. Both of the surveys showed the water of the reservoirs to be in good condition. It was also stated that no serious trouble from odor or any difficulty in filter operation might be anticipated from the number of organisms present. It might be possible during extreme periods of warm weather and drought and the decay of vegetables might give rise to extreme growth of micro-organisms to cause annoyance. This proved to be true later on.

In the summer of 1919, Danville experienced a severe drought, covering a period from July 1 to the latter part of October. The rainfall had been deficient not only during this period, but during all the preceding months of the year. The lower reservoir was

[1] Topical discussion before the Illinois Section Meeting, March 30, 1922.

[2] Superintendent, Water Company, Danville, Ill.

drawn down five feet, but was maintained at that level by allowing water to flow from the upper reservoir through a gate in the dam down stream into the lower reservoir. In doing this the upper reservoir was drawn down nine feet.

On August 18 a taste and odor suddenly appeared in the water, which was obnoxious and rendered the water unpalatable, although, from the bacterial standpoint, it was safe for drinking purposes. Inspection of the reservoirs on August 20 and 21 showed patches of green scum and in places there were noted streaks of brick-red scum. This was not continuous over the water, but in patches. Its effect seemed to be distributed, however, throughout the reservoir, for the water, even where no scum existed on the surface, had a reddish cast. The amount of scum was not nearly so great in area as had been found in previous years, but was composed of a different form of micro-organisms. On August 26, Miss Jewell, of the State Water Survey, made a microscopical examination of the water in both reservoirs. The organisms found at this time were euglena, peridinium, anabaena, arcella, diatoms and rotifers, showing euglena to be the predominant form. The first three organisms are known to impart a fishy and oily taste to the water and the fourth a grassy or moldy taste.

Samples of the filtered water were sent to the State Water Survey on August 11 and 21, September 8 and 30 and October 6. The analyses of all of these showed the water to conform to the United States Treasury Department's Standard for purity of water used on interstate carriers, although the taste and odor were still evident.

On August 27 the lower reservoir was treated with copper sulphate, by dragging a bag from the stern of a boat. One and a half pounds or 0.2 part per million were used, as nearly as could be determined. This treatment had no effect upon the taste and odor of the water. On September 30, Dr. Edward Bartow, chief of the State Water Survey, and R. E. Greenfield made a further investigation. Upon their recommendation the upper reservoir was treated with copper sulphate, as it passed through the gate channel in the dam, at the rate of five pounds per million gallons, and also the lower reservoir again treated, but at a rate of eight pounds per million gallons. The application of the copper sulphate at the upper reservoir was made from a barrel provided with a faucet set over the gate channel and calibrated to give the required rate of flow of the copper sulphate solution with which the barrel was charged. This treatment was

started on October 2 and was continued until October 9. About October 7 the taste and odor began to disappear and in a few days the character of the water was back to normal. There had not been sufficient rainfall to affect the river until about October 5, at which time and, also upon October 9 a heavy rainfall occurred, which may have been a factor in bringing about the improvement.

In the year 1920 an unusually severe drought occurred, covering a period from June to December. The lower reservoir was drawn down eleven feet and the upper reservoir sixteen feet. During this period there was a slight odor at times, but not enough to cause annoyance. No microscopical examinations were made during this period.

In the year 1921 the water company bought a microscope and began making frequent examinations in order to anticipate any possible trouble, by gaining knowledge of the condition of the reservoir and by beginning the copper sulphate treatment early enough. The organisms found during that summer were volvox, protococcus, pediastrium and scendesmus, all of the chlorophycea group; peridinium of the protozoan group and anabaena of the cyanophyceae group. Of the above named organisms, volvox and peridinium impart the fishy taste; anabaena the moldy taste; the other organisms are not troublesome. We were able to eliminate the fishy odors, but not altogether the moldy odors, by copper sulphate treatment and aeration. The moldy odor lasted only several weeks, and while rather disagreeable, was not nearly so serious as the odor in the year 1919.

Remedies for taste and odors. The copper sulphate treatment has been discussed and we will now consider aeration.

In 1920 it became necessary to make improvements to our filtration plant. These improvements consisted of an additional filter, a large sedimentation basin, together with mixing chamber and an aerator. These were designed by Mead and Seastone, Consulting Engineers, Madison, Wis. These improvements were completed and put in service in August, 1921. The aerator was built for the purpose of attempting to remove the taste and odor from the water. The aerator consists of a group of fountains set in a concrete basin. The fountains are vertical iron pipes near the top of which are placed perforated boiler plate conical hoods. The water flowing from the top of these pipes falls down over the hoods through the perforations in them, so as to break up the water and expose it to the air.

As the aerator was not completed until August, 1921, there has not yet been sufficient opportunity to make a thorough test of its efficiency in removal of taste and odor. However, as mentioned before, in the year 1921 we did have micro-organisms in the raw water, causing a fishy and moldy taste. The fishy taste was removed by aeration, but as stated we were not altogether entirely able to eliminate the moldy taste from the anabaena organisms. We trust that all these objectionable tastes and odors may be removed with a more thorough copper sulphate treatment than was given in the summer of 1921, together with aeration. Our experience along these lines has not yet been sufficiently broad to state just what may be accomplished by copper sulphate and aeration, but we believe we will be able to improve materially the character of the water when such tastes and odors occur.

In November, 1921, some odor in the river water was removed by aeration. At that time no microscopical examinations were made. We do not know, therefore, what organisms caused the odor at that time.

Up to date, in the year 1922, it has not been necessary to use the aerator.

Mr. H. F. Ferguson:[3] Mt. Vernon had the same experience with tastes and odors in the public water supply in the late fall and early winter of 1919–1920 as at Danville in 1920–1921. The tastes and odors occurred during the cold weather. In December the water in the lower reservoir became low and they increased the supply by bringing water from the upper reservoir. These conditions are somewhat similar to those at Danville, in that they have lower and upper reservoirs and let the water flow down the stream from the upper reservoir and then pump from the stream into the lower reservoir.

We were not sure whether the development of the organisms in the water, resulting in the tastes and odors, were due to the inflow from swamp land surrounding the lower reservoir, following a thaw, or whether the organisms originated in the upper reservoir of creek water. We were not advised of the situation until too late for satisfactory microscopic examinations. Analyses of samples made towards the end, when the taste began to disappear, showed euglena

[3] Chief Engineer, State Department of Health, Springfield, Ill.

to be present. That was our first experience at Mt. Vernon at that season of the year. We had it frequently in the late summer and early fall.

Regarding the case at Danville, we went there in November, 1919, at the request of the local health officer He thought the water was dangerous because of the taste and odor. Taste and odor do not necessarily represent dangerous water, although their physiological effect is sometimes bad on people and may tend to lower their general physical or mental condition. As an example of the indirect effect on health of the presence of tastes and odors in a public supply, I might cite one instance at Danville The city water was safe, although it had taste and odor. School authorities ordered the bubbling fountain in one school closed and installed a barrel and water was carried from a shallow dug well located only about 15 feet from a privy and decidedly subject to contamination from it. This was a case where all the taste and odor did not endanger the health, but the supply they resorted to did endanger their health. Our department feels that, although the tastes and odors in waters are not dangerous to health, it is important to try to get rid of them, if possible, because when they exist people resort to unsafe supplies in preference to drinking those having tastes and odors.

Mr. E. M. Greenfield:[4] I should like to say a few words about the work carried on by the State Water Survey in 1916 and 1917. Mr. Mickle did most of the work. It was carried on principally as a research problem, which is within the province of the State Water Survey, with the aim of finding out whether the Illinois reservoirs were subject to growths of odor-producing organisms. The work was discontinued in a short time on account of war time conditions, but as far as we went we practically proved that there were odor-producing organisms in all Illinois reservoirs. These odors were not present at all times because conditions were not the same at all times, but when certain conditions prevail we may expect the development of odors in any reservoir. That was true of the Danville reservoir and of all the reservoirs we visited. Just a word in reference to Mt. Vernon. The engineering firm of Alvord & Burdick asked Dr. Bartow to survey that reservoir in 1919, at the same time Mr. Ferguson speaks of. At that time we found synura in the lower

[4] Illinois State Water Survey, Urbana, Ill.

reservoir in large quantities. The odor was such as always has been described as synura. There was no synura in the upper reservoir or in Casey Fork, so that it would seem that if they had made arrangements to use the upper reservoir during that period they would not have had that trouble. Most people think that water becomes stagnant in the winter and synura is especially prone to come in spring when the ice is just breaking up. Mt. Vernon was running true to form, therefore, in the synura growth.

Many water works men think they are free from algae due to a lack of seed in the reservoir. However, they are there. It is just simply a matter of the proper seed bed. I might say that there is no method that has ever produced satisfactory results in all cases.

I might also say that, when a state department is called in to visit you in case of trouble like this and any treatment is recommended, if it does not work, we should like to know it. Next time we would not recommend that treatment. If it does work successfully, we should like to know that. If you consult the literature on the odors and tastes problem you will find it meager. There is no routine treatment for water that has no odor that can be expected to work in all cases. It is for the most part a matter of research. Aeration is a possibility. It works sometimes. I think it worked at Danville, but it will not in all cases. I will say that the Southern Illinois Public Service Co. has always followed up with information and this criticism is not directed at them.

Mr. Wm. Molis:[5] In Davenport, where river water is used trouble was had last year when taste and odor came on. They emptied the reservoir and cleaned it out. They also increased the chlorine to 18 pounds per million gallons, but that did no good. They then emptied the reservoir again. Then they decided to treat the water with copper sulphate and that was the only thing that cured the water. When the river was muddy they did not have trouble, but as soon as the river cleared up the trouble began. Algae will not grow in muddy water, but grows rapidly in clear water.

We had the same experience at Muscatine. We have driven wells and had been operating for 20 years without any experience from tastes and odors, but last summer we got taste and odor in our water. I immediately emptied the reservoir, and cleaned it out and

[5] Superintendent, Water Works, Muscatine, Iowa.

increased the chlorine dose. I had never used the chlorine apparatus before. We had it installed for emergency purposes.

A MEMBER: Your reservoir is not in a river bed?

Mr. WM. MOLIS:[5] No it is up on a high elevation. We get just as much algae in winter as we do in summer. The temperature of the water is about 50 degrees. I did not try the copper sulphate treatment for the reason that we found it was against public favor.

A MEMBER: Even Chicago with its reservoir has trouble with odors. About two years ago the lake turned over in a remarkable way. At times the odor was so bad from the lake that even in a theater you might suspect a dog under the seat. At times, very frequently in fact, there seems to be a chlorine taste. It may be due to wastes from the Standard Oil Co. at Whiting, Ind. In my home, which is about 35 miles distant from that point, we get a taste which I think comes from a gas plant. It may be the action of the chlorine on some of the refuse matter.

USE OF ILLINOIS WATERS IN WABASH LOCOMOTIVE BOILERS[1]

By O. W. Carrick[2]

Most of the waters used for boiler purposes in Illinois (if not treated) will cause the formation of large amounts of carbonate and sulphate scale. We have read and heard much about the losses due to scale formation in boilers and of the many different compounds and methods by which this expensive evil may be overcome.

The treatment of water used by stationary boilers is a simple matter, but when one starts to soften the waters used by locomotives, he is confronted by a problem more complicated and of greater magnitude. Comparatively few railroads have given any system of water treatment a trial, due in part to the difficulty in presenting actual results and financial savings large enough to justify the required investment. Some of the methods of treatment tried did not produce encouraging results. For this reason treatment of boiler waters has been looked upon as uncertain in its beneficial results.

To obtain results in any business, it must first be systematized. In this paper I shall present some gratifying results obtained on the Wabash Railway by the systematic treatment of all Illinois waters used by this road, that contain sulphate of lime and magnesia, with just enough soda ash to neutralize this hardness and to provide an excess or sodium carbonate in water in the boiler.

In this state the Wabash runs over Decatur Division, which covers territory from St. Louis to Chicago and Danville, and Springfield Division, serving territory from Decatur to Hannibal, Quincy and Keokuk. In the spring of 1912 every water station on these two divisions of the Wabash was visited. The regular and all other available supplies were investigated and analyzed to determine the treatment necessary, and whether a better supply, needing less treatment, might be obtained. It was found that water for locomo-

[1] Read before the Illinois Section meeting, March 30, 1922.

[2] Water Engineer, Wabash Railway, Decatur, Illinois.

tive use was taken from 14 wells, 13 streams, 11 reservoirs and 1 "stream and well."

The following analyses, expressed in parts per 100,000, and other information cover present supplies on the Decatur Division:

PLACE	SOURCE OF SUPPLY	GALLONS USED DAILY	ALKALI SALTS	TOTAL HARDNESS	SULPHATE HARDNESS	SODIUM CARBONATE
Landers	Lake Michigan	300,000	2.2	13.8	1.3	0
Marley	6 inch well, 134 feet	60,000	6.0	47.2	8.2	0
Manhattan	10 inch well, 110 feet	80,000	1.0	44.0	4.0	0
Custer Park	Kankakee River	90,000	6.6	28.4	11.9	0
Campus	Ditch	30,000	2.3	27.5	12.5	0
Forrest	Dug well, 40 feet		4.5	44.5	14.0	0
Forrest	8 inch well, 100 feet	175,000	13.5	36.6	0	2.4
Gibson City	8 inch well, 57 feet	80,000	1.0	31.3	3.3	0
Mansfield	10–8 inch well, 213 feet	60,000	6.4	30.6	0	6.4
Bement	2–10 inch well, 144 feet	200,000	9.3	41.2	0	6.0
Danville	City-Vermillion River	60,000	1.1	25.9	6.4	0
Sidney	10 inch well, 50 feet	75,000	12.2	30.5	0	9.0
Sadorus	Ditch	25,000	3.8	31.2	7.2	0
Decatur	City-Sangamon River	550,000	2.6	27.8	5.4	0
Stonington	Well 34 foot City	35,000	2.4	30.6	0	2.4
Taylorville	Well 10 inch 80 feet	135,000	9.8	44.0	17.0	0
Morrisonville	Reservoir	30,000	5.6	16.4	8.4	0
Litchfield	City-Reservoir & Cr.	135,000	2.0	18.5	3.8	0
Mt. Olive	Reservoir-City	60,000	4.4	7.2	1.7	0
Edwardsville	Wells-City	60,000	2.8	19.4	2.4	0
Brooklyn	Miss. River-City	200,000	5.5	9.5	5.5	0

The Springfield Division waters show similar analyses, except that none contain free sodium carbonate.

It will be noted that the total hardness of the majority of these waters is high, but that the sulphate hardness in most cases is of such character that it requires only a moderate amount of soda ash to break this hardness. The alkali salts are not excessive. Our analytical work requires only total hardness and alkalinity determinations at wayside tanks by a traveling chemist and total dissolved solids determination in the laboratory, to obtain alkali salt content or foaming tendency of the waters.

Observation of boilers in the Wabash pumphouse at Mansfield has shown no scale formation on the heating surfaces after years of service. This water is obtained from a well 213 feet deep, which has a total hardness of 30.6 with natural sodium carbonate of 6.4 parts per 100,000. Waters of this character are desirable. In our work on water treatment we have been able to change the supply in several instances from the sulphate hardness water to water of

the above character, doing away in this manner with the necessity for treatment.

With the above information, recommendations were made with estimate of cost and kind of plant for treating the water, with soda ash alone, similar to that at Mansfield, providing blow-off boxes in which engines were to be blown at terminals, and changing sources of supply where better ones were available. Two inexpensive methods, by which soda ash solution is forced into wayside tanks when raw water is flowing, were put in service. Where city water is used and the pumphouse is some distance from a wayside tank, a by-pass plant operated by back pressure is installed to by-pass raw water to a drum, where soda solution is displaced. A diaphragm is placed in the drum to separate solution from raw water. The back pressure is developed by putting an "orifice" in a thin plate in the discharge pipe and a flow of solution, in direct proportion to the flow of water, is discharged into the wayside tank. The other method is the forcing of solution into the tank by a small duplex pump. These plants call for an expenditure of from \$150 to \$800 depending upon type of plant and length of pipe line.

Failure to maintain continuous treatment results in scale on the flues and firebox sheets. This condition will exist if treatment is permitted to become 10 to 20 per cent too light. It is essential, therefore, to provide chemical supervision to keep instructions for the use of soda ash correct and to eliminate neglect of treatment. There must be also enough support from officers in charge to insure a minimum amount of neglect by the soda ash tenders.

One traveling chemist is able to take care of the treatment at 20 to 30 water stations. Such a man carries an analysis case with sampling bottles and chemicals, for collecting and analyzing raw and treated waters while at the plant. From the analysis of the raw water he calculates the number of pounds of soda ash needed to treat it. From the analysis of the treated water he determines amount of soda ash used. If the raw water has changed in hardness, directions are changed accordingly. If the treatment does not check the directions he takes steps to locate trouble. The analytical work requires from 10 to 20 minutes and it is his duty to see that the treatment is correct before he leaves for the next water station. He is required also to ride locomotives and to advise enginemen as to the effects of using treated water and the amount of blowing off of boilers necessary; to check up the use of soda ash in stationary

boilers; to watch the washing of locomotives to see that no scale is given up, to collect samples of water from boilers on different occasions in order to get a check on treatment in general, to note if enginemen are blowing enough water out of boiler to keep the water from foaming and to check the blowing of engines at terminals.

With the addition of soda ash to water the foaming tendency of the water is increased. When a lime-soda-ash softener is used part of the incrusting solids will settle out, but the the alkali soda salts and the foaming tendency remains. With our method of treatment we do not have settling tanks, for we find that the lime salts cause no trouble in the boilers as these solids when precipitated are blown out through a properly located blow-off cock.

We have made road tests and thousands of waters taken from boilers have been analyzed, the results of which show that the water will foam in a locomotive boiler when the concentration of dissolved solids is about 2400 parts per million. It is necessary then to do enough blowing to keep the solids below this concentration. To relieve the enginemen of this work engines are blown by hostlers at terminals before being put in the roundhouse. This terminal blowing is essential as the locomotive is dispatched with water in good condition.

Much has been said about the heavy cost of blowing out necessary to keep down foaming. We realize that considering the waste of fuel and water, the cost of blowing off is possibly the major part of the cost of water treatment, but this cost for any given territory may be easily calculated. On our Decatur Division, where the treatment will average 0.7 pounds of soda ash per 1000 gallons of water, about 4.5 per cent of the water will have to be blown out to keep boiler from foaming. This will entail a fuel waste of approximately 1.2 per cent of the coal used. The total cost of the coal and water wasted would be about $0.03 per 1000 gallons. This cost of blowing out should never deter one from treating water, as it is much more than off-set by fuel saving and other benefits resulting from clean heating surfaces.

ENGINE FAILURES DUE TO LEAKY FLUES, STAY BOLTS, FIRE BOXES, ETC.

The metal in locomotive boilers is continually undergoing excessive strains when covered with a coat of scale, which results in weakening cracks, checks and other failures. A failure due to boiler leakage is an expensive one since it involves usually giving

up the train and having another engine go out after the train and the failed engine. When this engine is brought into the terminal, inspection may show that, on account of the heavy scale formation, the flues and firebox are in such condition as to require new tubes or patching of the firebox before it may again be dispatched, resulting in an engine being out of service for several days, with more locomotives necessary. Wabash locomotive boilers, after being in service four years, contain practically no scale. The following table shows improvement in the way of reducing leakage failures for the year 1921, as compared with the year 1911, the latter being the year before treatment was started.

DIVISION	NUMBER OF FAILURES		DECREASE	MILES PER FAILURE	
	1911	1921		1911	1921
			per cent		
Decatur	232	4	98.3	20,878	989,068
Springfield	57	0	100.0	33,303	No failures
Total	289	4	98.6	27,090	1,173,618

It will be noted that on the Decatur Division the failures were reduced 98.3 per cent and on the Springfield Division all failures were eliminated, making a decrease for both Divisions of 98.6 per cent. The mileage per failure increased from 27,090 in 1911 to 1,173,618 in 1921.

In July 1917, 25, 2-10-2 engines with 23 foot flues were placed in service on Decatur Division, before treatment considered our hardest water Division. During the 4½ years of service there have been seven failures due to leaky flues. The average time to the first resetting of flues was 39 months and the average flue mileage on the ten highest engines is 116,477. Engine 2525 (which is now in shop for its first set of flues) made 127,313 miles. Our passenger engines are making from 200,000 to 300,000 miles between flue resettings. It is not an unusual occurrence to obtain permission to run flues beyond the four-year limit set by the Goverment as the time in which all flues should be renewed.

FIRE BOX RENEWALS

I do not have figures showing the decrease in firebox renewals for locomotives running in Illinois alone, but this information,

covering the road where treated water is used, shows a reduction for the last three years of 93 per cent over 1915, the year in which the effect of water treatment on this part of the locomotive work was really felt.

STAY BOLT RENEWALS

There has been a decided decrease in staybolt breakage in engines operating in Illinois since water treatment was started, and for the past few years about one bolt per engine per year is renewed. The 2-10-2 engines previously mentioned have 3047 staybolts, including 2320 rigid stays, 639 American flexible stays and 88 Tate flexible staybolts. There have only been fourteen staybolts broken on the entire 25 engines. On our Canadian Division, where treatment has not been established and which has not as bad water as Decatur before treatment was started, the broken bolts per engine per year are 52.

FUEL PERFORMANCE

Marston Taylor Bogert, in an address before the American Chemical Society, said: "In the United States the average thickness of locomotive boiler scale is $\frac{1}{16}$ inch; this means a loss of at least 13 per cent in fuel efficiency, or, for our 51,000 locomotives alone, a total annual loss may be estimated conservatively at 15 million tons of coal." Up to 1919, our record of fuel saving on the basis of pounds of coal per 100-ton miles shows a decrease of 21.25 per cent over 1912. We do not attribute all of this decrease to water treatment, as the extended use of the superheater engines and brick arch, and the formation of a competent fuel organization have had also their bearing on this saving.

In the preceding pages, I have tried to cover in a general way our method of treatment of waters used in Wabash locomotives in Illinois, together with a few of the results obtained. By systematic treatment of these waters we have been able to accomplish the following principal results:

1. Practical elimination of engine failures due to leaky flues, firebox, staybolts, mud rings, etc.

2. Reduction of fuel consumption by keeping heating surfaces comparatively free from scale.

3. Reduction of staybolt breakage and firebox renewals and repairs to a very low figure.

4. Decreased cost of boiler repairs from 30 to 65 per cent.

5. Increased mileage between boiler washings to any desired amount.

6. Operation with fewer engines, due to engines not being held in roundhouse and shops for boiler work.

I believe that the majority of men present are users of steam made by stationary boilers and are interested in keeping them free from incrustation. Our method of doing this is to pump soda ash solution directly into the boiler, twice daily, by means of a small duplex pump. The amount to be pumped is calculated from the amount of water evaporated and the sulphate hardness of the water. All heating surfaces are kept practically free from scale, which results in long life of boiler and in greater efficiency.

DISCUSSION

A. S. Behrman.[3] Mr. Carrick has made several statements that have left me wondering. The average permanent hardness of the Illinois waters Mr. Carrick discusses is slight as compared with the bicarbonate hardness. Mr. Carrick stated that the average quantity of soda ash required per thousand gallons is about 0.6 pound, equivalent roughly to a permanent hardness of 1 grain per gallon. The temporary hardness in these waters, on the other hand will run anywhere from 6 to 20 grains per gallon. In other words, the soda ash treatment is a good deal like removing the tail of the dog, but leaving the dog there. This temporary hardness is going to appear, upon evaporation of the water, as a deposit of scale or sludge and the sediment formed will hasten foaming. It is an accepted fact that sediment in water tends to make the water foam. As a matter of fact, some authorities state that waters free from sediment will not foam even with extremely high concentrations of soluble salts. I have been wondering why the Wabash Railroad decided on this method of water treatment, which considers such a small part of the substances which form scale or sludge and cause foaming

O. W. Carrick:[2] In the paper I gave an instance of practically no scale being formed in our Mansfield Illinois pumphouse boiler, which uses water with a total hardness of 30.6 and sodium carbonate of 6.4 parts per 100,000.

[3] Chief Chemist, International Filter Company, Chicago, Ill.

After plants have been installed over a division and enough soda ash has been used to neutralize the sulphate hardness, making the treated water similar to the natural non-scaling waters, the total hardness and suspended matter is precipitated in the form of a soft sludge in the water leg of the locomotive firebox. Critical examination of the deposit has shown that the large portion settles along the back leg, which is the point of least circulation.

Our blow off cocks are located in the left back corner and have a perforated pipe connected to them which extends across the full width of the firebox and lies on the back mud ring. To prevent foaming it is necessary to do enough blowing to keep the alkali salts or dissolved solids below a concentration of 2400 parts per 1,000,000 by weight. Incidental to this blowing the sludge is also removed. Inspections of the interior of boilers, when due for washout, have shown that it is possible to run locomotives indefinitely without a washout and without any foaming, if the blow off cock is properly used.

C. R. Knowles:[4] It is difficult to fix a definite concentration of dissolved solids in a locomotive boiler without foaming. Whether a boiler will foam or not depends upon other factors, chief among which is the amount of matter in suspension.

Mr. C. H. Koyl, of the Chicago, Milwaukee & St. Paul, has stated that it is possible to carry 1,000 grains per gallon, while I have known cases where violent foaming occurred with a concentration of only 50 grains per gallon. Therefore, it is impossible to fix a definite concentration at which foaming will occur.

We began treating water on the Illinois Central about years ago. During this time I believe we have used every kind of treatment known from potato peelings to barium hydrate. We do not confine ourselves to any one form of treatment. For example, we have water treatment plants using lime and soda ash at twelve stations in Iowa and eight in Illinois. We are now also using interior treatment or what is commonly known as boiler compound at 75 stations over the system. We have several filter plants in operation for the removal of suspended matter. Only about 25 per cent of the water in Illinois requires treatment. Seventy-five per cent of the water either does not require treatment or may be treated with

[4] Superintendent, Water Service, Illinois Central Railroad, Chicago, Illinois.

soda ash or some form of boiler compound. It would certainly be a mistake to recommend the soda ash treatment as a remedy for all boiler evils, for, as stated by Mr. Behrman, removing the sulphate hardness and leaving the carbonate hardness in the water is certainly not complete treatment. In fact, we have many waters high in carbonates and in some cases practically devoid of sulphates.

A. S. Behrman:[3] Foaming is in some cases as important, if not more important, than scale, for a scaly boiler may frequently be operated, even though inefficiently, where a foaming boiler cannot be operated at all. Foaming is not entirely dependent on the factor Mr. Carrick emphasizes, that is, on the concentration of soluble salts. It has been shown definitely that the concentration of soluble salts may be carried much further without foaming, if suspended matter is absent.

Furthermore, the soda ash treatment alone does not provide the hydrate alkalinity certainly protective to boilers and which minimizes corrosion. This hydrate alkalinity is secured, of course, when lime is used. All things considered, I do not see any comparison between this partial treatment with soda ash, and a combined lime-soda treatment properly carried out. Proper lime-soda treatment will provide a water that is non-corrosive, that will form absolutely no scale, and that will yield a minimum of suspended matter upon concentration. The soda ash treatment alone will not do these things.

O. W. Carrick:[2] The question arises as to whether it would be more economical to treat water by the lime-soda ash process or by soda ash alone. Mr. Behman states that, with the former method, the alkali salts in a boiler may be carried to a higher concentration before foaming takes place, due to the lime solids being removed.

The saving due to the reduction in blowing off may be calculated at a definite amount per 1000 gallons of water evaporated and set against interest, depreciation, and operating charges for the softeners. At the same time, it must be remembered that there is a possibility of one or more or these plants not operating properly. This would mean an increase in lime solids which would result in lowering the concentration to a point possibly not much greater than with other methods of treatment.

By using soda ash alone in a systematic way, very gratifying results have been obtained on the Wabash. With due consideration to other methods for scale prevention, we feel that our method is quite satisfactory and least expensive.

C. R. Knowles:[4] The American Railway Engineering Association, Committee on Water Service, prepared definitions on foaming, together with recommendations for the prevention of foaming. I was a member of the Committee and know that the conclusions were arrived at only after extensive study had been made.

This Committee went on record as stating that foaming was primarily caused by suspended matter. I think one of the best examples of boiler water treatment is that on the Great Northern Railroad. If I am correctly informed, there is one district on the Great Northern where they are operating successfully with water containing from 60 to 80 grains of soda ash per gallon. It should, be understood, of course, that the locomotives on this district used only treated water, as the addition of a half a boiler of untreated water would create a condition of foaming that would be worse than the use of the water without treatment.

The results obtained on the Great Northern are very convincing. With regard to suspended matter being an important factor in the foaming of locomotive boilers, several roads have installed filters in connection with their water softening plants for the removal of all suspended matter after treatment. This should go far towards keeping down the quantity of suspended matter in the boiler. The installation of filters will pay undoubtedly a handsome return on the investment through reducing foaming in locomotives.

G. C. Habermeyer:[5] Regarding the difference in practice of the different railroads, we might cite the case at Mendota where the C. B. & Q. and the I. C. have wells within 400 feet. I understand both supplies were treated, but after a number of years the C. B. & Q. R. R., although they have a plant available, are using the water without treatment, while the I. C. consider it proper to treat their water from the same source.

C. R. Knowles:[4] In regard to Mr. Habermeyer's reference to Mendota. It is true we have a plant at that point, where the water

[5] Civil and Sanitary Engineer, Urbana, Ill.

is treated with lime and soda ash. I may add, however, that we use very little soda ash, as the water runs 12 or 15 grains carbonate hardness, with only a trace of sulphates. This is a case where the soda ash treatment as recommended by Mr. Carrick would be of little benefit.

As stated by Mr. Habermeyer the C. B. &. Q., only a few hundred feet away from us, use this water without treatment. The Q. at one time maintained a plant at this point and afterwards abandoned it and treated with soda ash for a time. If I am correctly informed, the reason for abandoning the plant was that it did not provide for increased consumption. While the water we use at Mendota is not considered among our worst waters, at the same time we feel justified in treting it for the reason that we intend to equip this entire district with treatment plants.

REPORT OF COMMITTEE ON REVISION OF STANDARD SPECIFICATIONS FOR CAST IRON PIPE AND SPECIAL CASTINGS[1]

Your Committee is not able to recommend at the present time any definite revision of existing specifications, but progress toward this ultimate goal has been made.

As stated in last year's report, the important questions in the work of revision are those in reference to uniform outside diameter, chemical specifications, the requirements of a definite relation between breaking load and flexure, and the development of a better standard of coating.

No final decision as to the uniform outside diameter has been reached. The users, as indicated by the canvas of last year, are about equally divided for and against this change in the present specifications. The manufacturers have always been opposed, but, if—as now seems probable—the centrifugal method of casting pipe should prove a commercial success, a uniform outside diameter will necessarily be adopted for pipe so cast, and the manufacturers using this process will see, undoubtedly, the problem in a new light.

On the question of specifying the chemical quality of the metal and a definite relation between breaking load and flexure, the outstanding event of the year was the submission to the Committee of the report of Dr. Richard Moldenke, who had been employed by the manufacturers to make an extensive investigation. This investigation involved the casting of some 800 test bars at eight different foundries—one-half of which were cast according to the present water works standard 1 inch by 2 inch flat bar, and the other half according to the A. S. T. M. standard $1\frac{1}{4}$ inch circular "arbitration" bar. All bars were broken transversely and in the case of the round bars one or more of those showing a transverse strength nearest to the average transverse strength were taken for complete chemical analyses and tensile test. The report is a very voluminous and valuable document and, with the permission of the manufacturers, portions of it might well be published in the Journal of the Association.

[1]Presented before the Philadelphia Convention, May 17, 1922.

As to the feasibility of a specification for chemical quality of the metal, Dr. Moldenke finds strongly in the negative, except in the case of sulphur for which he suggests a maximum limit of 0.12 per cent in lieu of the 0.10 per cent recommended by the Committee in the tentative revision issued several years ago. His reasons for opposing the specification of chemical quality is that no constituent has an effect which is not dependent upon the amount of other constituents, that the analysis of a test bar may be quite different from the analysis of the same metal when cast in the pipe, and that the final value of the metal is dependent on many other conditions than are disclosed by chemical analyses of a sample taken from the ladle.

Your Committee has reached no conclusion in reference to the adoption of specifications of chemical qualities. We are impressed by Dr. Moldenke's argument and also by the expense and time required to make analyses as a day by day part of the work of inspection, and it is not improbable that the final decision will be that such specifications, with the exception of sulphur, are impracticable. It is of interest, however, to note that by a very slight widening of the limits set by the chemical specification included in the tentative revision of the Committee, all the bars analyzed by Dr. Moldenke would pass and that, on the other hand, practically all the freak irons which have been found by Mr. McInnes in pipe, which have been broken in use and which he is to describe to this Convention, have analyses which would have thrown them into the discard, if subject to the chemical specifications suggested by the Committee.

In reference to the specification of a relation between breaking load and flexure in test bars the manufacturers have accepted the principle involved as sound and a reasonable means of checking the possible development of strength at the expense of resiliency.

At the first conference with the manufacturers in January it was agreed that the Chairmen of the New England and American Committees should prepare a tentative draft of a revised test bar specification. As submitted to the manufacturers, this draft called for a transverse breaking load of not less than 1900 pounds, a deflection for bars breaking at 1900 pounds of not less than 0.30 inch, and for bars breaking at higher loads a deflection of 0.30 inch plus 0.025 inch for each 200 pounds of load in excess of 1900 pounds. When this specification was applied by Dr. Moldenke to the bars broken by him, it was found that a large percentage would be rejected. As these bars were fairly representative of present practice, this result

at once raised questions as to whether a more resilient iron is necessary and as to whether such an iron can be economically produced.

At a meeting with the Foundrymen's Test Bar Committee on April 15th, your Committee took the position that the revised specification should lead to the development of the best metal which is economically possible and should not be framed on the assumption that the present irons are as good as can be produced at reasonable cost. It was admitted that the percentage of scrap used —owing to high freight rates and war residues—is now and will be for years to come abnormally high, and while the manufacturers insist that they are making as good pipe as at any time in the history of the industry, it was the judgment of the Committee that a further investigation should be undertaken to determine whether a better material than that tested by Dr. Moldenke is economically possible. Accordingly the manufacturers generously undertook to finance further work by Dr. Moldenke and he, in coöperation with Mr. Conard of the Joint Committee, was authorized to determine by actual variation of the mixture of pig iron and scrap, at one or more foundries, whether an iron which will more nearly meet the tentative specifications for relation between breaking load and flexure can be economically produced. This work is already begun and it is hoped that the report will be available before the end of the year. The Committee at the present time is unable, therefore, to specify definite figures for a relation between breaking load and flexure.

Obviously, the thanks of the Association are due the manufacturers for their coöperation in the work of the Committee as, in the absence of any appropriation, the Committee can only make progress as it obtains the assistance of the producers.

One of the interesting recommendations of the Moldenke report is that a new test bar, 20 inches long, circular in section, with a diameter of $1\frac{3}{8}$ inches, to be broken between supports 18 inches apart, should be adopted instead of the present water works standard 1 inch by 2 inch flat bar which is broken between supports 24 inches apart. The Committee is not convinced that the circular bar is an improvement, but it has subscribed to Dr. Moldenke's recommendation to the manufacturers that parallel tests on the present and suggested type of bars should be carried on for six months.

In the problem of developing an improved coating no definite progress has been made during the year, and, in the absence of any available funds there appears to be little prospect of being able to undertake experimental work.

Present methods of coating pipe have small regard for the present specifications. The material used is generally crude coal tar, or inferior water gas tar and not a "pitch"—as required by the specifications, except so far as the crude tar is refined to a pitch by the distillation which takes place in the dipping tank. Temperatures are not accurately controlled and overheating, particularly in the case of heavy pipe, is responsible for thin brittle coatings of little value as a protection to the metal.

The manufacturers will furnish just as good a coating as the users of pipe demand, and it is the present feeling of the Committee that the most direct road to the development of a better standard is for those engineers and superintendents, who appreciate the economy of maintaining the carrying capacity of pipe lines, to adopt a specification which will guarantee the use of a straight run coal tar pitch and such control of the heating of the pipe and bath as will prevent injury to this material in its application to the pipe. The tentative specifications for tar issued by your Committee in 1916 will insure the use of coal tar pitch.

Your Committee believes that, in view of the possible fundamental effects of certain new processes of making pipe on the problem of standarization, it is perhaps fortunate that we have made progress slowly in reaching any definite revision of existing specifications.

This report is unanimously approved by the Committee.

F. A. Barbour, *Chairman*,
Walter Wood,
Edward E. Wall,
N. F. S. Russell,
Wm. C. Hawley,
Wm. W. Brush.

THE VICTAULIC PIPE JOINT

By Thorndike Saville[1]

Late in 1919 the writer had an extended interview in London with Dr. Hele-Shaw, a noted English hydraulic engineer. Dr. Hele-Shaw had been engaged by the British Government during the war and in conjunction with L. Tribe had devised a special form of joint for use on pipes and cylinders containing gases and chemicals under very high pressures. After the war it occurred to the inventors of this joint that it was equally applicable to general commercial use for conveyance of water, oil and other liquids. The writer saw the investigations being carried on with this end in view and received permission to be the first to describe it for the benefit of the engineering profession in the United States.

There was much unexpected delay in developing the process of manufacture of the joint so that, in addition to its manifest structural advantages, it could compete in price with other forms of pipe joint. During the past month (May, 1922) the writer has been informed by Dr. Hele-Shaw's associates that this joint is now being produced on a commercial basis, and may be brought to the attention of American engineers and water works officials.

A cross section of the simplest form of joint is shown in figure 1 and a photograph of a joint for 3-inch pipe on the right in plate 1. Basically, the joint is a development of the "U" washer or packing, but eliminates the tendency of this type of water seal to leak at low pressures by uniting the two outer lips. Moreover, the inner lips are of slightly less diameter than the outside of the pipe and hence exercise an initial grip on the ends of the pipes as they are placed in the joint, preventing leakage at low pressures. Then, as water or other pressure is put on the pipe the initial grip of the inner lips increases, the tension becomes compression, and the greater the pressure on the pipe, the tighter the joint becomes.

[1] Associate Professor of Hydraulic and Sanitary Engineering, University of North Carolina, Chapel Hill, N. C. Chief Hydraulic Engineer, North Carolina Geological and Economic Survey.

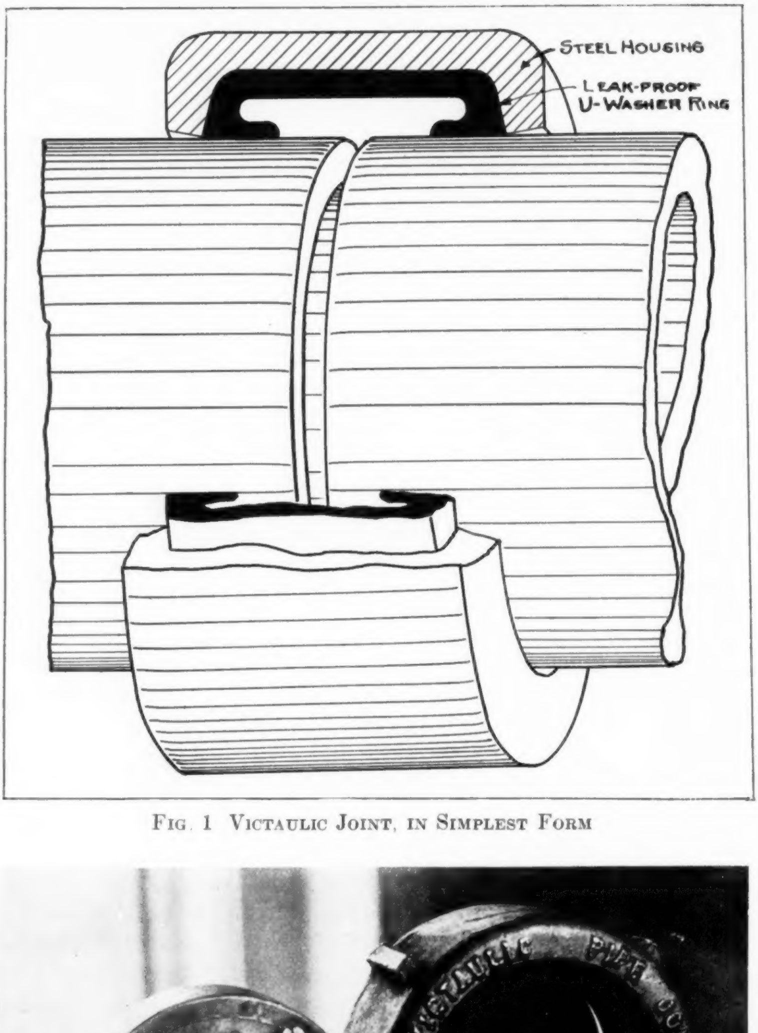


FIG. 1 VICTAULIC JOINT, IN SIMPLEST FORM

PLATE I

The joint consists of a cast iron or cast steel housing, containing the leak proof washer or ring. When used on water pipes, the material of the inner ring is india rubber, which has been found to be practically indestructible when kept wet and protected from light. When used on pipes carrying steam, gasoline, oil, chemicals, corrosive gases, etc., a special material called "Victaulite" has been developed, which has proved extremely durable under the most rigid tests. Indeed, with true British thoroughness, the inventors have kept this joint off the market for two years, until this material could be perfected and the joint rendered suitable for all purposes.

It is stated that the joint is also proof against leakage from the outside in the event of a partial or total vacuum on the inside of the pipe. This arises from the fact that the end walls of the leak-proof ring are set at an angle, forming a frustrum of a cone. This buttressed end wall, in tending to deflect under an internal vacuum, exercises an increasing grip on the pipe in precisely the same manner as the inner lip acts under a positive pressure, and prevents the ingress of fluids or gases from the outside.

For ordinary pressures up to 300 pounds per square inch, where pipe is buried in ground or otherwise fixed to prevent movement, the type "A" joint shown on the right in figure 1 is used. The pipe needs no preparation or special casing such as a bell, but consists simply of a straight uniform cylinder. Where pressures are greater or where it is desired to secure the joint positively against end displacement under pressure, the type "B" joint is recommended by the makers. This is shown in figure 2 and on the left in plate 1. These joints are normally for use up to 650 pounds per square inch pressure. For very high pressures, up to 2500 pounds per square inch the type B joint is modified somewhat, and ends of the pipe are recessed to hold the leakproofed ring. Another modification of the joint permits great flexibility over that inherent in the normal type A or B joint. While type A joint is simply slipped on over the ends of the pipe, type B joint has to be assembled in place. Plate 2 shows type B joint unassembled. The Victaulic joints have been adapted to a great variety of purposes, such as all kinds of iron, steel and concrete pipe (see figure 3); the heads of collapsible barrels and cylinders, gland rings, etc. The joints are now produced in quantity in sizes to fit pipe having outside diameters from 1 to 24 inches. Larger sizes have to be specially made at present.

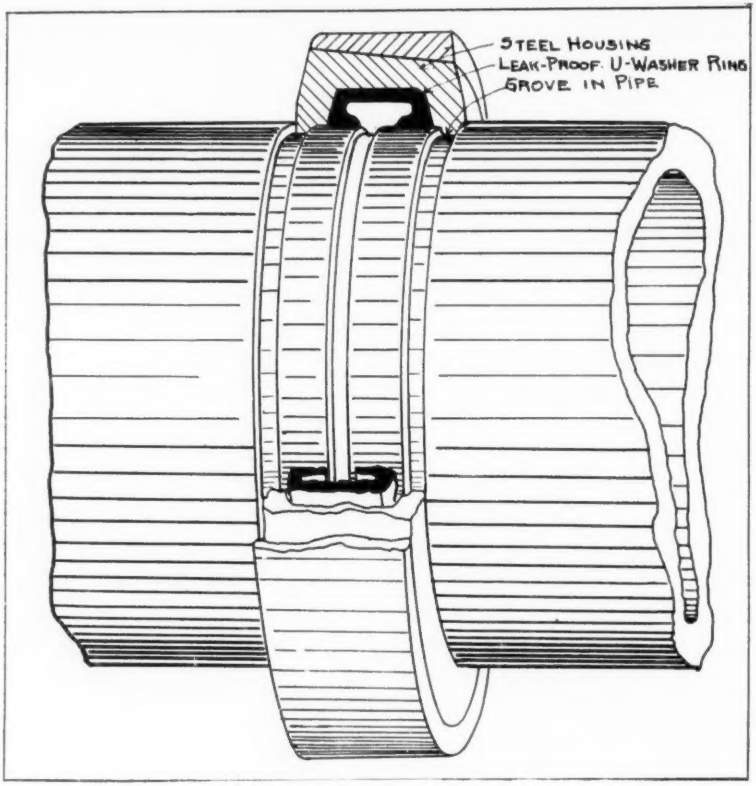


FIG 2. VICTAULIC JOINT—ADAPTED TO PREVENT MOVEMENT OF PIPE

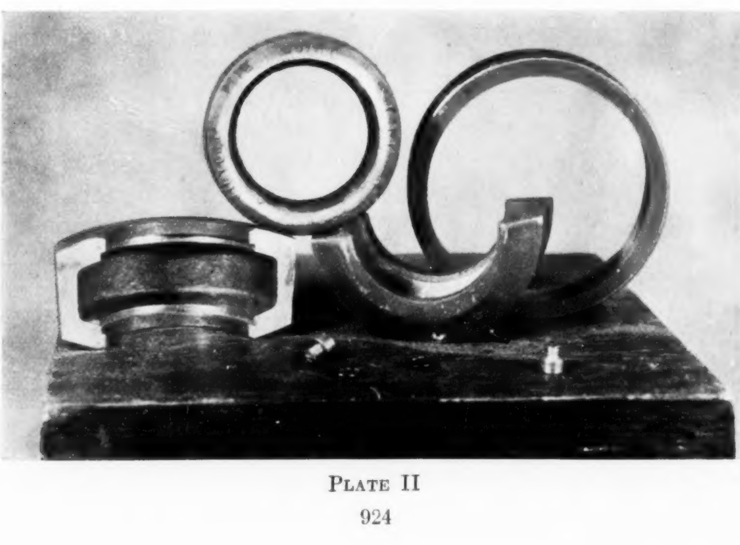


PLATE II

Advantages claimed for the "Victaulic" joint are:

1. Eliminates additional expense of casting bells on ordinary cast iron bell and spigot pipe. It lends itself particularly to use on centrifugally cast iron pipe, enabling this to be cast without the single bell form now necessary.

2. Eliminates cost of machining on various patented forms of pipe and pipe joint.

3. Eliminates cost of materials, labor and time incident to making ordinary lead or compound joint. The Victaulic joint may be placed on two pipes in about two minutes, by unskilled workmen. It may be placed on large pipe nearly as quickly and easily as on small pipe.

4. Eliminates additional excavation needed for bell holes in ordinary pipe. Saves much space in piping installations in tunnels, buildings and ships, since room for calking does not have to be allowed, and access to only one side of pipe is necessary.

5. The Victaulic joint has a high degree of flexibility, and especially in water pipe, where the leak-proof ring is of india rubber, the pipe may be several degrees out of alignment, may be subject to repeated vibration or lateral movements without causing leakage. Similarly, the tightness of the joint is unaffected by expansion or contraction of the pipe material. No expansion joints are necessary.

6. There is a material saving in weight, and consequently in freight, over the ordinary forms of pipe and joint. This is particularly the case as the size of pipe or pressure increases.

7. When it becomes necessary to remove a length of pipe, it is only necessary at most to slip back two joints. Cutting of the pipe, fitting of the sleeve, etc., are eliminated, saving time and expense.

8. The joint is absolutely leak-proof, under high or low pressure or vacuum.

9. Trouble from electrolysis is reduced, since current will not leave pipe at joint, but will continue over metal housing.

10. On temporary pipe lines, laid on surface of ground, no alignment of pipe or ground is necessary, since flexibility of joint makes pipe conform to surface irregularities. This increases speed in laying and reduces cost.

Due to the great care taken by Dr. Hele-Shaw and his associates in working out the details of the Victaulic joint, it has been on the market only about a year. Up to within about a month the cost of the joint itself has been so high that it could not compete in local

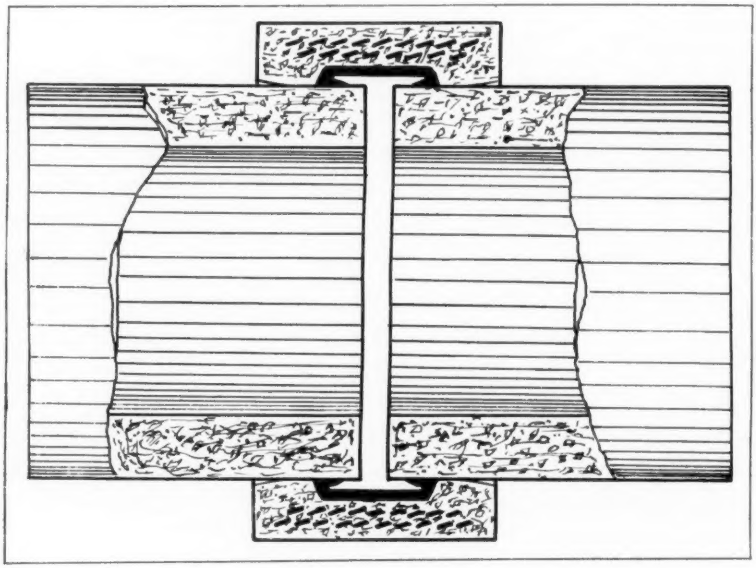


Fig. 3. Victaulic Joint for Concrete Pipe

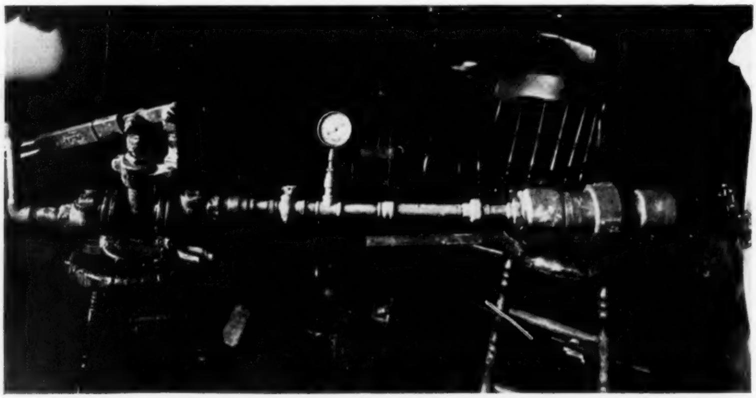


Plate III

installations with the ordinary pipe joints, except where specially severe conditions made the extra expense of the superior Victaulic joint worth while. So far as the writer is aware, the joint is not yet manufactured in the United States, but quantity production has been reached in England and the principal pipe manufacturers are making pipe adapted to this joint. The cost of the joint in England is now where it may compete in first cost with other types of joint, and several installations are being made. For particular conditions and special conditions such as cited above, numerous installations have already been made.

The joint has been subjected to many tests in England, both by the manufacturers and others. Colonel Davidson, Chief Engineer of the Liverpool Corporation Water Works has written the writer that he has "subjected the joint to all manner of tests in our testing shops, with satisfactory results." Through the courtesy of Dr. Hele-Shaw, two sample joints were sent the writer and have been tested by him. A photograph of the type "A" joint under test pressure of 140 pounds per square inch is shown in plate 3. The joint was flexible at this pressure and did not leak. Tests were made at the shops of the Durham Water Works, through the kindness of the Chief Engineer, Captain John C. Michie.

In England, installations of the pipe lines with the Victaulic joint have been made at Dartford on a 16-inch sewage line, and at London on a 6-inch hydraulic force main at 750 pounds per square inch pressure. A number of oil lines have been fitted with this type of joint. The Metropolitan Water Board of London have authorized the use of it for trial on 500 feet of a new water line.

The writer is indebted to Dr. Hele-Shaw for calling his attention to this new type of pipe joint and for arranging with his associates and the Victory Pipe Joint Co., Ltd., the makers of the joint, to supply additional data and samples for testing.

STANDARD SPECIFICATIONS FOR PRESSURE WATER FILTERS[1]

RATES OF FILTRATION

Rates of filtration are based upon the "Report of Committee on Recommended Standardization of Filters" of the American Society of Mechanical Engineers, presented at the annual meeting of the A.S.M.E. December, 1916. This report fixes the rate of filtration for potable water as follows:

> "Whenever the water is to be used for domestic purposes or to secure full bacterial purification, the capacity shall be based on a rate of filtration not to exceed 2 gals. per minute per square foot of filtering area and a coagulant must be used."

A full report of the committee is contained in Transactions of A.S.M.E. for 1917, pages 425–432.

Rates of filtration for various uses should conform to the following schedule:

2 gals. per sq. ft. per minute for all supplies used for drinking, or for the preparation of food products.

2 to 4 gals. per sq. ft. per minute when filtering a treated municipal supply of approved bacterial purity.

2 to 4 gals. per sq. ft. per minute for swimming pools, and for all industrial uses.

2 to 5 gals. per sq. ft. per minute as conditions may warrant for double filtration, using sand followed by charcoal where reduction of color, odor, taste or certain forms of iron is desired. This method of filtration not to be applied for bacterial purification.

---

[1] Adopted by Associated Manufacturers of Water Purifying Equipment.

Capacities of filters for rates of 2, 3 and 4 gallons per square foot per minute

Diameter		Length	Area	Capacities per min.			Pipe connections		Min. wash water at 12 gals. per sq. ft. per min.
				2 gals. per sq. ft.	3 gals. per sq. ft.	4 gals. per sq. ft.	Inlet outlet filter wash	Waste to sewer	
Vertical filters									
ft.	*in.*	*ft.*	*sq. ft.*	*gals.*	*gals.*	*gals.*	*in.*	*in.*	*gals.*
1	0		0.785	1.57	2.35	3.14	¾	1	9.42
1	2		1.06	2.12	3.18	4.24	1	1¼	12.72
1	4		1.39	2.78	4.17	5.56	1	1¼	16.68
1	8		2.18	4.36	6.54	8.72	1¼	1½	26.16
2	0		3.14	6.28	9.42	12.5	1½	2	37
2	6		4.90	9.8	14.7	19.6	1½	2	60
3	0		7.06	14.1	21.1	28.2	2	2½	84
3	6		9.62	19.2	28.8	38.5	2	2½	115
4	0		12.56	25.1	37.6	50.2	2½	3	150
4	6		15.90	31.8	47.7	63.6	2½	3	190
5	0		19.63	39.2	58.8	78.5	3	4	235
6	0		28.27	56.5	84.8	113.1	4	5	339
7	0		38.48	76.9	115.4	153.9	4	5	460
8	0		50.27	100.5	150.8	201.1	5	6	600
Horizontal filters									
8	0	10	68.5	137	205.5	274.0	6	8	822
8	0	12	83.4	166.8	250.2	333.6	6	8	1000
8	0	14	98.2	196.4	294.6	392.8	6	8	1178
8	0	16	113.1	226.2	339.3	452.4	8	10	1357
8	0	20	142.7	285.4	428.1	570.8	8	10	1712
8	0	25	179.8	359.6	539.4	719.2	8	10	2157

Length is over-all length of filter, and area of bed is calculated for surface of bed 18 in. above center of shell.

Area of segments of the 2 dished heads = 9.2 sq. ft.

Area per lineal foot of bed in the cylinder = 7.42 sq. ft.

Example: 8x16 ft. filter—Area in heads = 9.2 sq. ft.

Area in cylinder, 14x7.42 = 103.9 sq. ft.

Total effective area = 113.1 sq. ft.

Construction of vertical steel pressure filters

DIAMETER	WORKING PRESSURE								
	65 lbs. per sq. in.			100 lbs. per sq. in.			125 lbs. per sq. in.		
	Shell		Head	Shell		Head	Shell		Head
	Min. joint eff.	Thickness	Thickness	Min. joint eff.	Thickness	Thickness	Min. joint eff.	Thickness	Thickness
in.	*per cent*	*in.*	*in.*	*per cent*	*in.*	*in.*	*per cent*	*in.*	*in.*
24	50	$\frac{3}{16}$	$\frac{1}{4}$	50	$\frac{3}{16}$	$\frac{1}{4}$	50	$\frac{1}{4}$	$\frac{5}{16}$
30	50	$\frac{3}{16}$	$\frac{1}{4}$	57	$\frac{1}{4}$	$\frac{5}{16}$	50	$\frac{5}{16}$	$\frac{5}{16}$
36	50	$\frac{3}{16}$	$\frac{1}{4}$	57	$\frac{1}{4}$	$\frac{5}{16}$	70	$\frac{1}{4}$	$\frac{3}{8}$
42	57	$\frac{1}{4}$	$\frac{5}{16}$	70	$\frac{1}{4}$	$\frac{3}{8}$	70	$\frac{5}{16}$	$\frac{7}{16}$
48	57	$\frac{1}{4}$	$\frac{5}{16}$	70	$\frac{1}{4}$	$\frac{3}{8}$	70	$\frac{5}{16}$	$\frac{7}{16}$
54	57	$\frac{1}{4}$	$\frac{5}{16}$	70	$\frac{5}{16}$	$\frac{7}{16}$	70	$\frac{3}{8}$	$\frac{1}{2}$
60	57	$\frac{1}{4}$	$\frac{3}{8}$	70	$\frac{5}{16}$	$\frac{7}{16}$	67	$\frac{7}{16}$	$\frac{1}{2}$
72	72	$\frac{1}{4}$	$\frac{3}{8}$	69	$\frac{3}{8}$	$\frac{1}{2}$	66	$\frac{1}{2}$	$\frac{9}{16}$
84	70	$\frac{5}{16}$	$\frac{7}{16}$	66	$\frac{1}{2}$	$\frac{9}{16}$	66	$\frac{9}{16}$	$\frac{11}{16}$
96	69	$\frac{3}{8}$	$\frac{7}{16}$	68	$\frac{1}{2}$	$\frac{5}{8}$	68	$\frac{5}{8}$	$\frac{3}{4}$

Standard manholes 11x15 in. or 10x16 in.
Tensile strength of steel plate 55,000 to 65,000 lbs. per sq. in.
Heads dished to radius of diameter of tank.
Hydrostatic test 50 per cent in excess of working pressure.

Construction of cast iron pressure filters

DIAMETER	WORKING PRESSURE			
	65 lbs. per sq. in.		100 lbs. per sq. in.	
	Shell thickness	Head and flange thickness	Shell thickness	Head and flange thickness
in.	*in.*	*in.*	*in.*	*in.*
12	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{5}{8}$	$\frac{7}{8}$
14	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{11}{16}$	$\frac{15}{16}$
16	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{11}{16}$	$\frac{15}{16}$
20	$\frac{11}{16}$	$\frac{15}{16}$	$\frac{3}{4}$	1
24	$\frac{11}{16}$	$\frac{15}{16}$	$\frac{13}{16}$	$1\frac{1}{16}$
30	$\frac{3}{4}$	1	$\frac{7}{8}$	$1\frac{1}{8}$
36	$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{15}{16}$	$1\frac{3}{16}$
42	$\frac{13}{16}$	$1\frac{1}{16}$	1	$1\frac{1}{4}$
48	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{16}$	$1\frac{5}{16}$

Filters to be gray iron castings having a tensile strength of approximately 20,000 lbs. per sq. in.

Hydrostatic test 50 per cent in excess of working pressure to be applied.

Heads dished to radius equal to diameter of shell may be modified with rib reinforcement to same thickness as shell.

Variations of $\frac{1}{8}$ in. in these thicknesses of shells and heads and flanges to be permissible.

PROGRESS REPORT OF THE COMMITTEE ON STANDARD FORM OF CONTRACT[1]

During 1921–1922 a large amount of coöperative preliminary work has been done on the standardization of forms of contract for construction work. The organizations which have appointed delegates to participate in the work are the American Institute of Architects, American Railway Engineering Association, Associated General Contractors of America, American Society of Civil Engineers, American Engineering Council, Association of State Highway Officials, National Association of Builders Exchanges, Western Society of Engineers and American Water Works Association. The American Bar Association was invited to coöperate but decided that such standardization was not within the field of its activities. In some cases, a participating society has been represented by the chairman and one or more members of its committee having contract forms in its charge and in other cases specially appointed delegates have participated. At the meetings each society had one vote. It is gratifying to report that while the discussions of some topics showed great differences of opinion at the outset, it has always been practicable to reach a conclusion to which all delegates, or practically all, agreed.

A great amount of preparatory work in compiling the comparable clauses in several hundred construction contracts was first done by the office organization of Gen. R. C. Marshall, Jr., general manager of the Associated General Contractors of America. This work showed that there is a substantial likeness already existing between many contract forms and that the various clauses of the average contract could be grouped into two parts, an agreement which would be generally applicable with but few minor changes and a statement of the general conditions which would be substantially modified in some details for each general class of construction. Documents of this character were prepared under General Marshall's direction and the first conference of delegates met in Washington in December to

[1] Presented before the Philadelphia Convention, May 17, 1922.

discuss them. The sessions were held at the Department of Commerce and Secretary Hoover has shown continuing interest in the work, placing at the disposal of the delegates all the facilities his department can furnish. Onward Bates, past-president of the American Society of Civil Engineers, was chosen chairman; John W. Cowper, president of the John W. Cowper Company, of Buffalo, was chosen vice-chairman, and Ward P. Christie, research engineer of the Associated General Contractors, was chosen secretary.

It developed that the standard form of contract of the American Institute of Architects had been used so extensively and so successfully that it was desirable to give special consideration to the helpful precedents it furnished. The standard form of contract of the American Railway Engineering Association is also used widely as the basis of contracts for a large amount of work of widely varying character. This first conference, therefore, requested the delegates of these two organizations and General Marshall to prepare contract documents which would harmonize the points of difference in the various forms discussed at these December sessions.

The second conference was held at the Department of Commerce in Washington on April 14 and 15. At this meeting there were presented a Universal Agreement and General Conditions for Railroad Construction and similar documents for building construction. These two sets of documents were discussed at length for the purpose of harmonizing them to the utmost possible degree.

The difficulty of attempting to produce standard contract documents applying equally well to contracts with an arbitration clause and those without one proved insurmountable at this time, so it was decided to concentrate attention for the present on documents with such a clause. The standard documents of the American Institute of Architects are of this class. Most of the delegates favored an arbitration clause and none of the delegates were opposed to it on principle. The criticisms of it were mainly from the delegates of the American Railway Engineering Association, which has preferred contracts without an arbitration clause to those with one, on account of the special conditions under which railway construction work is carried out.

At the April conference a universal agreement for use, with a few verbal changes, for any kind of construction contract having a provision for arbitration, was developed to the point where the delegates felt the document might profitably be submitted for the

criticism of the committees of the various societies they represented. This universal agreement as adapted for railway construction is as follows:

THIS AGREEMENT made the .... day of .... in the year Nineteen Hundred and .... by and between .... hereinafter called the Constructor, and .... hereinafter called the Company WITNESSETH, that the Constructor and the Company for the considerations hereinafter named agree as follows:

ARTICLE I. SCOPE OF WORK. The Constructor shall perform all the work shown on the Drawings and described in the Specifications entitled..........

....

(Here insert the caption descriptive of the work as used in the Proposal, General Conditions, Specifications and upon the Drawings)

.... prepared by .... acting as, and in these Contract Documents entitled the Chief Engineer, and shall do everything required by the General Conditions of the Contract, the Specifications and the Drawings.

ARTICLE II. TIME OF COMPLETION. The work to be performed under this Contract shall be substantially completed ....

(Here insert the date or dates of completion, commencement if desired, and stipulations as to liquidated damages, if any)

....

ARTICLE III. THE CONTRACT SUM. The Company shall pay the Constructor for the performance of the Contract, subject to additions and deductions as provided herein, a sum of money as follows ....

(Here insert either a lump sum or unit prices and approximate quantities)

....

Where the quantities originally contemplated are so materially changed that the application of the agreed unit price to the addition or deduction is shown to create a hardship to the Company or the Constructor, there shall be an equitable adjustment of the Contract to prevent such hardship.

ARTICLE IV. PROGRESS PAYMENTS. The Company shall make payments on account of the Contract as provided therein as follows:

On or about the .... day of each month ninety per cent of the value, proportionate to the amount of the Contract, of the labor and materials incorporated in the work and of materials suitably stored at the site thereof up to the first day of that month as estimated by the Engineer, less the aggregate of previous payments. ....

....

....

(Insert here any provision to be made for limiting or reducing the amount retained after the work reaches a certain stage of completion)

ARTICLE V. ACCEPTANCE AND FINAL PAYMENT. The Engineer shall promptly make final inspection for acceptance upon receipt of written notice that the work is ready for such inspection, and shall within.................... days after the Constructor has fully completed the work make a final estimate of the work performed, and shall execute a certificate over his signature stating that the work provided for in this Contract has been completed and

accepted by him under the terms and conditions thereof; and the entire balance found to be due the Constructor shall be paid to him within .... days after he has fully performed all of his contractual obligations.

If, when the work has been substantially completed, it should develop that full completion thereof is delayed through no fault of the Constructor, or if for any other reason the Engineer deems it advisable, the Company shall pay the Constructor subject to the provisions of the Contract governing liens, within .... days after the date of such substantial completion, an amount equal to the final payment less the cost of all uncompleted work; but before either this amount or the final estimate is payable the Constructor shall submit evidence satisfactory to the Chief Engineer that all pay-rolls, material bills and other indebtedness connected with the work have been paid.

ARTICLE VI. THE CONTRACT DOCUMENTS. The General Conditions of the Contract, the Specifications and the Drawings, together with this Agreement, shall form the Contract, and they are as fully a part of the Contract as if hereto attached or herein repeated; the following is an exact enumeration of the Specifications and Drawings: ....
....

ARTICLE VII. DECISIONS OF THE ENGINEER. The Engineer shall, within reasonable time, make decisions on all claims of the Constructor and all other matters relating to the execution and progress of the work or the interpretation of the Contract Documents.

ARTICLE VIII. INSPECTION OF THE WORK. The Engineer and his representatives shall at all times have access to the work wherever it is in preparation or progress and the Constructor shall provide proper facilities for such access and inspection.

If the specifications, the Engineer's instructions, laws, ordinances or any public authority require any work to be specially tested or approved, the Constructor shall give the Engineer timely notice of its readiness for inspection, and if the inspection is by another authority than the Engineer, of the date fixed for such inspection. Inspections by the Engineer shall be promptly made, and where practicable at the source of material supply. Inspection made at the source of supply shall not constitute acceptance of material subsequently damaged.

If any such work should be covered up without approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination at the Constructor's expense.

Re-examination of questioned work may be ordered by the Engineer. If such work be found in accordance with the Contract, the Company shall pay the cost of re-examination and replacement. If such work be found not in accordance with the Contract, the Constructor shall pay such cost, unless he shall show that the defect in the work was caused by another constructor, and in that event, the Company shall pay the cost.

ARTICLE IX. CORRECTION OF THE WORK BEFORE FINAL PAYMENT. The Constructor shall promptly remove from the premises all materials condemned by the Engineer as failing to conform with the Contract, whether incorporated in the work or not, and the Constructor shall promptly replace and re-execute his own work in accordance with the Contract and without

expense to the Company and shall bear the expense of making good all work of other constructors destroyed or damaged by such removal or replacement.

If the Constructor does not remove such condemned work and materials within a reasonable time, fixed by written notice, the Company may remove them and store the material at the expense of the Constructor. If the Constructor does not pay the expense of such removal within a reasonable time therefor, thereafter the Company may, upon ten days written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Constructor.

ARTICLE X. DEDUCTIONS FOR UNCORRECTED WORK. If the Chief Engineer deems it inexpedient to correct work injured or done not in accordance with the Contract, the difference in value together with a fair allowance for damage shall be deducted, the amount deducted to be determined by agreement or arbitration.

ARTICLE XI. PROTECTION OF WORK AND PROPERTY: EMERGENCIES. The Constructor shall continuously maintain adequate protection of all his work from damage and shall protect the Company's property from injury arising in connection with this Contract. He shall make good any such damage or injury except such as may be directly due to errors in the Contract Documents or agents or employes of the Company. He shall adequately protect adjacent property as provided by law and the Contract Documents. He shall provide and maintain all passage ways, guard fences, lights and other facilities for protection necessitated by public authority and local conditions.

In an emergency affecting the safety of life or of the work or of adjoining property, the Constructor, without special instruction or authorization from the Engineer, is permitted hereby to act, at his discretion, to prevent such threatened loss or injury and he shall so act, without appeal, if so instructed or authorized. Any claim for compensation on account of emergency work shall be passed upon by the Engineer.

ARTICLE XII. CHANGES IN THE WORK. The Company, without invalidating the Contract, may order extra work or make changes by altering, adding to or deducting from the work, the contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original Contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change.

In giving instructions the Engineer shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purpose of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Engineer, and no claim for an addition to the Contract sum shall be valid unless so ordered.

The value of such extra work or change shall be determined in one or more of the following ways:

(a) By estimate and acceptance in a lump sum.

(b) By unit prices named in the Contract or subsequently agreed upon.

(c) By cost and percentage or by cost and a fixed fee.

(d) If none of the above methods is agreed upon, the Constructor, provided he receive an order as above, shall proceed with the work, no appeal to arbitration being allowed from such order to proceed.

In cases (c) and (d), the Constructor shall keep and present in such form as the Engineer may direct, a correct account of the net cost of labor and materials, together with vouchers. In any case, the Engineer shall certify to the amount due to the Constructor. Pending final determination of value, payments on account of charges shall be made at the Engineer's estimate.

Article XIII. Extra Work. (This clause as first written was made unnecessary by a modification of Article XII. The original number has not been altered, as to do this would cause needless confusion at this stage of the work of standardization and comparison with existing standard contract forms.)

Article XIV. Claims for Extra Cost. If the Constructor claims that any instructions by drawings or otherwise involve extra cost under this Contract, he shall give the Engineer written notice thereof before proceeding to execute the work except in emergency endangering life or property, and in any event, within two weeks of receiving such instructions, and the procedure shall then be as provided for in changes in the work. No such claim shall be valid unless so made.

Article XV. Payments Withheld. The Company may withhold or, on account of subsequently discovered evidence, nullify the whole or a part of any estimate for payment to such an extent as may be necessary to protect itself from loss on account of

(a) Defective work not remedied.

(b) Claims filed or reasonable evidence indicating filing of claims or liens.

(c) Failure of the Constructor to make payments properly to subcontractors or for material or labor.

(d) A reasonable doubt that the Contract can be completed for the balance then unpaid.

(e) Damage to another Constructor.

When all the above grounds are removed payment shall be made for amounts withheld because of them.

Article XVI. Delays and Extension of Time. If the Constructor be delayed in the completion of the work by any act of negligence of the Company or of its employes or by any other constructor employed by the Company or by changes ordered in the work, or by strikes, lockouts, fire, unusual delay by common carriers, unavoidable casualties or any causes beyond the Constructor's control, or by delay authorized by the Chief Engineer pending arbitration, or by any cause which the Chief Engineer shall decide to justify the delay, then the time of completion shall be extended for such reasonable time as the Chief Engineer may decide will compensate for such delay.

No such extension of time shall be made for delay occurring more than seven days before claim therefor is made in writing to the Engineer. In the case of a continuing cause of delay, only one claim is necessary.

If no schedule or agreement, stating the dates upon which drawings shall be furnished, is made, then no claim for delay shall be allowed on account of failure to furnish drawings until two weeks after demand for such drawings and not then unless such claim shall be reasonable.

This article does not exclude the recovery of damages for delay by either party under other provisions in the Contract documents.

ARTICLE XVII. THE COMPANY'S RIGHT TO DO WORK. If the Constructor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the Company, after three days' written notice to the constructor, may without prejudice to any other remedy he may have, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Constructor.

ARTICLE XVIII. COMPANY'S RIGHT TO TERMINATE CONTRACT. If the Constructor should be adjudged a bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should persistently or repeatedly refuse or fail, except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials, or if he should fail to make prompt payment to sub-contractors, or for material or labor, or persistently disregard laws, ordinances or the instructions of the Engineer, or otherwise be guilty of a substantial violation of any provision of this Contract, then the Company, upon the certificate of the Chief Engineer that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Constructor seven days' written notice, terminate the employment of the Constructor and take possession of the premises and of all materials, tools and appliances thereon and finish the work by whatever method it may deem expedient. In such case the Constructor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the contract sum shall exceed the expense of finishing the work, including compensation for additional managerial and administrative services, such excess shall be paid to the Constructor. If such expense shall exceed such unpaid balance, the Constructor shall pay the difference to the Company. The expense incurred by the Company as herein provided, and the damage incurred through the Constructor's default, shall be certified by the Chief Engineer.

ARTICLE XIX. CONSTRUCTOR'S RIGHT TO STOP OR TERMINATE CONTRACT. If the work should be stopped under an order of the court, or other public authority, for a period of three months, through no act or fault of the Constructor or of any one employed by him, or if the Engineer should fail to issue any estimate within seven days after it becomes due, or if the Company should fail to pay the Constructor within seven days of its maturity and presentation, any sum certified by the Engineer or awarded by the arbitrators, then the Constructor may, upon three days' written notice to the Company and the Engineer, stop work or terminate this Contract and recover from the Company payment for all work executed and the loss sustained upon any plant or material and reasonable profit and damages.

ARTICLE XX. DAMAGES. If either party to this contract should suffer damage in any manner because of any wrongful act or neglect of the other party or of any one employed by him, then he shall be reimbursed by the other party for such damage.

Claims under this clause shall be made in writing to the party liable within a reasonable time of the first observance of such damage and not later than

the time of final payment, except as expressly stipulated otherwise in the case of faulty work or materials and shall be adjusted by agreement or arbitration.

ARTICLE XXI. ASSIGNMENT. Neither party to the contract shall assign the contract or sublet it as a whole without the written consent of the other, nor shall the Constructor assign any moneys due or to become due to him hereunder, without the previous written consent of the Chief Engineer.

ARTICLE XXII. CONSTRUCTOR'S LIABILITY INSURANCE. The Constructor shall maintain such insurance as will protect him from claims under workmen's compensation acts and from any other claims for damages for personal injury, including death, which may arise from operations under this Contract, whether such operations be by himself or by any subcontractor or anyone directly or indirectly employed by either of them. Certificates of such insurance shall be filed with the Chief Engineer, if he so require, and shall be subject to his approval for adequacy of protection.

ARTICLE XXIII. LIENS. Neither the final payment nor any part of the retained percentage shall become due until the Constructor, if required, shall deliver to the Company a complete release of all liens arising out of this Contract or receipts in full in lieu thereof, and, if required, in either case an affidavit that so far as he has knowledge or information the releases and receipts include all the labor and materials for which a lien could be filed; but the Constructor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the Company, to indemnify it against any lien. If any lien remain unsatisfied after all payments are made, the Constructor shall refund to the Company all moneys that the latter may be compelled to pay in discharging such lien, including all costs and a reasonable attorney's fee.

ARTICLE XXIV. PERMITS AND REGULATIONS. Permits and licenses of a temporary nature necessary for prosecution of the work shall be secured by the Constructor. Permits, licenses and surveys for permanent structures or permanent changes in existing facilities shall be secured by the Company.

The Constructor shall give all notices, pay all fees and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Constructor observes that the drawings and specifications are at variance therewith, he shall promptly notify the Engineer in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work. If the Constructor perform any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Engineer, he shall bear all costs arising therefrom.

ARTICLE XXV. ROYALTIES AND PATENTS. The Constructor shall pay all royalties and license fees. He shall defend all suits and claims for infringement of patent rights and shall save the Company harmless from loss on account thereof, except that the Company shall be responsible for all such loss when the product of a particular manufacturer or manufacturers is specified, but if the Constructor has information that the articles specified is an infringement of a patent he shall be responsible for such loss unless he promptly gives such information to the Engineer.

ARTICLE XXVI. SUPERINTENDENT SUPERVISION. The Constructor shall keep on his work during its progress a competent superintendent and any necessary assistants, all satisfactory to the Engineer. The superintendent shall not be changed except with the consent of the Engineer unless the superintendent proves to be unsatisfactory to the Constructor and ceases to be in his employ. The superintendent shall represent the Constructor in his absence and all directions given to him shall be as binding as if given to the Constructor. Important directions shall be confirmed in writing to the Constructor. Other directions shall be so confirmed on written request in each case.

The Constructor shall give efficient supervision to the work, using his best skill and attention. He shall carefully study and compare all drawings, specifications and other instructions and shall at once report to the Engineer any error, inconsistency or omission which he may discover.

ARTICLE XXVII. ARBITRATION. All questions in dispute under this contract shall be submitted to arbitration at the choice of either party to the dispute.

The Constructor shall not cause a delay of the work on account of any arbitration proceedings except by agreement with the Chief Engineer.

The demand for arbitration shall be filed in writing with the Chief Engineer in the case of an appeal from his decision, within ten days of its receipt, and in any other case within a reasonable time after cause thereof and in no case later than the time of final payment, except as otherwise expressly stipulated in the Contract. If the Engineer fails to make a decision within a reasonable time, an appeal to arbitration may be taken as if his decision had been rendered against the party appealing.

No one shall be nominated or act as an arbitrator who is in any way financially interested in this Contract or in the business affairs of either the Company or the Constructor.

The general procedure shall conform to the laws of the State in which the work is to be done. Unless otherwise provided by such laws, the parties may agree upon one arbitrator; otherwise there shall be three, one named, in writing, by each party to this Contract, to the other party and to the Chief Engineer, and the third chosen by these two arbitrators, or if they fail to select a third within ten days, then he shall be chosen by the presiding officer of the Bar Association nearest to the location of the work. Should the party demanding arbitration fail to name an arbitrator within ten days of his demand, his right to arbitration shall lapse. Should the other party fail to choose an arbitrator within said ten days, then such presiding officer shall appoint such an arbitrator. Should either party refuse or neglect to supply the arbitrators with any papers or information demanded in writing, the arbitrators are empowered by both parties to proceed ex parte.

The arbitrators shall act with promptness. If there be one arbitrator his decision shall be binding; if three, the decision of any two shall be binding. Such decision shall be a condition precedent to any right of legal action, and wherever permitted by law it may be filed in Court to carry it into effect.

The arbitrators, if they deem that the case demands it, are authorized to award to the party whose contention is sustained such sums as they shall

deem proper for the time, expense and trouble incident to the appeal, and, if the appeal was taken without responsible cause, damages for delay. The arbitrators shall fix their own compensation, unless otherwise provided by agreement, and shall assess the costs and charges of the arbitration upon either or both parties.

The award of the arbitrators must be in writing and, if in writing, it shall not be open to objection on account of the form of the proceedings or the award, unless otherwise provided by the laws of the State in which the work is to be done.

In the event of such laws providing on any matter covered by this article otherwise than as hereinbefore specified, the method of procedure throughout and the legal effect of the award shall be wholly in accordance with the said State laws, it being intended hereby to lay down a principle of action to be followed, leaving its local applications to be adapted to the legal requirements of the place in which the work is to be done.

ARTICLE XXVIII. EXECUTION, CORRELATION AND INTENT OF DOCUMENTS. The Contract documents shall be signed in duplicate by the Company and Constructor. In case of failure to sign the General Conditions, Drawings or Specifications, the Engineer shall identify them.

The Contract documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is to include all labor and materials reasonably necessary for the proper execution of the work. It is not intended, however, that materials or work not covered by or properly inferable from any heading, branch, class or trade of the Specifications shall be supplied unless distinctly so noted on the drawings. Materials or work described in words which so applied have a well known technical or trade meaning shall be held to refer to such recognized standards.

The Constructor and the Company for themselves, their successors, executors, administrators and assigns, hereby agree to the full performance of the covenants herein contained.

IN WITNESS WHEREOF they have executed this agreement, the day and year first above written.

The conference also adopted for the special consideration of railway engineers and contractors, a set of General Conditions applicable particularly to railway work and supplementing the Agreement. These General Conditions cover the following heads:

Principles and definitions
Constructor's understanding
Serving notice to constructor
Materials, appliances and transportation
Property and right of way
Rights of various interests
Timely demand for points and instructions
Staking the work

Preservation of stakes
Reporting errors and discrepancies
Discipline of employes
Intoxicating liquors and drugs prohibited
Hiring company employes
Settlement for wages
Fire insurance
Work adjacent to railroad
Bond
Status of the engineer
Order of completion; use of completed portion
Suspension of work
Annulment without fault of constructor
Removal of equipment
Subcontracts
Monthly estimates
Cleaning up

The proposed universal form of contract Agreement as applied to building work is supplemented by a set of General Conditions covering

Principles and definitions
Detail drawings and instructions
Copies furnished
Shop drawings
Drawings and specifications on the work
Ownership of drawings and models
Samples
Materials, appliances, employes
Use of premises
Cleaning up
The architect's status
Applications for payments
Certificates of payments
Correction of work after final payment
Owner's liability insurance
Fire insurance
Guaranty bond
Cash allowances
Cutting, patching and digging
Mutual responsibility of constructors
Separate contracts
Subcontracts
Relations of constructor and subcontractor

No attempt has yet been made to prepare a universal form of agreement and a set of general conditions for water works construc-

tion or for any form of public work, as the delegates and their advisers have devoted their attention entirely to contracts between private parties. Contract forms for public work are more influenced by laws and regulations of public commissions than are contracts for private work, and the delegates to the conferences believed that it was desirable to investigate the less complex case first.

Your Committee submits the tentative draft of the general "Agreement" to the Association with a request that the members who prepare contract forms for private work during the next year consider the practicability of employing the suggested clauses. Your Committee has not yet had an opportunity to study these clauses and while it is considering them during the next half year or so it will be glad to receive from any member of the Association his criticism of any part of the proposed Agreement. Where the wording of a clause is criticized the critic is asked to suggest a substitute wording. The Committee will be particularly glad to receive word of contracts for public works containing arbitration clauses.

Your Committee requests that this report be printed in the Journal and that the Committee be continued.

Respectively submitted,

J. Waldo Smith, *Chairman,*
Theodore A. Leisen,
John N. Chester,
Henry P. Bohmann,
Charles R. Gow,
Carleton E. Davis,
Thomas H. Wiggin,
G. A. Elliott,
John M. Goodell, *Secretary.*

REPORT OF SECRETARY FOR FISCAL YEAR 1921–1922

MEMBERSHIP REPORT FOR FISCAL YEAR ENDING MARCH 31, 1922

	Active	*Corporate*	*Associate*	*Honorary*	*Total*
Members April 1, 1921	1,286	104	147	3	1,540
New members received	192	15	16	0	223
Restored in year	12	3	0	0	15
Transferred from other classes	2	5	0	0	7
	1,492	127	163	3	1,785
Transferred to other classes	5	2	0	0	7
	1,487	125	163	3	1,778
Died	8	0	0	0	8
	1,479	125	163	3	1,770
Resigned	56	5	9	0	70
	1,423	120	154	3	1,700
Dropped Non-payment dues	89	2	1	0	92
Members April 1, 1922	1,334	118	153	3	1,608
Members April 1, 1921	1,286	104	147	3	1,540
Net gain for fiscal year	48	14	6	0	68

COMPARATIVE STATEMENT

	1921	*1922*
New members received		
Active	232	192
Corporate	6	15
Associate	23	16
Restored to membership		
Active	9	12
Corporate	1	3
Died, active	8	8
Resigned		
Active	42	56
Corporate	2	5
Associate	8	9
Dropped, non-payment dues		
Active	83	89
Corporate	7	2
Associate	1	1

TRIAL BALANCE, MARCH 31, 1922

2	Initiation fees		$1,205.00
17	Annual dues		11,915.50
37	Advertisements in JOURNAL		2,697.71
50	Interest on investments		530.00
53	Subscriptions to JOURNAL		633.03
62	Sales of JOURNAL		148.90
70	Sales of *Proceedings*		19.00
72	Interest on deposits		115.03
95	Hydrant and valve specifications		8.00
96	Exchange on checks	$27.65	
98	Pipe specifications		160.25
100	Convention expenses	800.00	
104	Office expenses	1,195.33	
113	Standardization Council	144.89	
115	Finance committee	17.55	
116	Membership committee	27.65	
117	Convention committee	33.28	
118	Publication committee	36.00	
119	Cast Iron pipe specifications committee	10.23	
120	Abstracts committee	19.41	
152	Canadian section	132.01	
154	Central states section	150.00	
156	Chemical and bacteriological section	64.50	
160	Illinois section	114.55	
162	Iowa section	104.98	
164	Minnesota section	49.00	
166	New York section	144.44	
168	North Carolina section	50.00	
176	Insurance	58.45	
178	Salary of editor	900.00	
182	Salary of secretary	800.00	
186	Salary of assistant to secretary	1,200.00	
188	Rent of office	1,080.00	
190	Printing JOURNAL	7,165.40	
195	Contingencies	245.00	
200	1917 binding cases	16.52	
202	1918 binding cases	38.48	
204	1919 binding cases	54.04	
208	1920 Binding cases	51.85	
211	1921 binding cases	37.25	
220	Author's reprints	58.50	
222	Electrolysis report	16.80	
234	Office equipment	108.40	
237	Surplus account		12,545.08
238	Investments	11,945.00	
	Balance cash on hand	3,080.34	
		$29,977.50	$29,977.50

This balance taken before transfer of subaccounts to Budget Accounts and shows amount drawn by each Local Section and the expenses of the various committees.

FINANCIAL STATEMENT

Cash on hand April 1, 1921		$234.74
Receipts:		
Initiation fees		1,205.00
Annual dues		11,915.50
Advertisements in JOURNAL		2,697.71
Interest on investments		530.00
Subscriptions to JOURNAL		633.03
Sales of JOURNAL		148.90
Sales of *Proceedings*		19.00
Interest on deposits		115.03
Hydrant and valve specifications		8.00
Pipe specifications		160.25
Binding cases		100.05
Electrolysis reports		184.25
Authors' reprints		285.72
		$18,237.18
Disbursements:		
Exchange on checks	$27.65	
Convention expenses	800.00	
Office expenses	1,195.33	
Insurance	58.45	
Salary of editor	900.00	
Salary of secretary	800.00	
Salary of assistant to secretary	1,200.00	
Rent of office	1,080.00	
Printing JOURNAL	7,165.40	
Contingencies	245.00	
Committee expenses	289.01	
Section expenses	809.48	
Binding cases	201.05	
Electrolysis' reports	41.25	
Authors reprints	344.22	15,156.84
Balance cash on hand April 1, 1922		$3,080.34

OPERATING STATEMENT

Operation income:	
Initiation fees	$1,205.00
Annual dues	11,915.50
Advertisements in JOURNAL	2,697.71
Interest on investments	530.00
Subscriptions to JOURNAL	633.03
Sales of JOURNAL	148.90
Sales of *Proceedings*	19.00
Interest on deposits	115.03
Hydrant and valve specifications	8.00
Pipe specifications	160.25
	$17,432.42

Operation expenses:		
Exchange on checks	$27.65	
Convention expenses	800.00	
Office expenses	1,195.33	
Insurance	58.45	
Salary of editor	900.00	
Salary of secretary	800.00	
Salary of assistant to secretary	1,200.00	
Rent of office	1,080.00	
Printing JOURNAL	7,165.40	
Contingencies	245.00	
Committee expenses	289.01	
Section Expenses	809.48	$14,570.32
Net profit from operation		$2,862.10
Loss from operation previous year		2,007.72
Improvement for this year		$4,869.82

Increased income from increase of dues:	
1306 Active members paid during year at $2 incr.	$2,612.00
113 Corporate members paid during year at $5 incr.	565.00
153 Associate members paid during year at $5 incr	765.00
	$3,942.00
Profit as shown above	2,862.10
At old rate of dues would have been deficit of	$1,079.90

Figures in this report are actual cash received and paid out on account of operation, with no account of balances or of dealings in binding cases, electrolysis reports and author's reprints.

SOCIETY AFFAIRS

MINNESOTA SECTION

At the tenth meeting of the Minnesota Section in Minneapolis on November 4, 1921, the resolution was passed authorizing the Section to hold its next meeting at the same time and place as the meeting of the League of Minnesota Municipalities.

The League of Minnesota Municipalities is an organization which has a membership comprised of 173 municipalities in the state of Minnesota. These municipalities are represented at the meetings by various local officials designated by them.

Shortly after the meeting on November 4, it was decided that this joint meeting should be held at Crookston, Minn. The purpose of holding this meeting at the same time as that of the League of Minnesota Municipalities was to familiarize municipal officials with the work of the American Water Works Association.

The program of the meeting was arranged with the purpose of providing papers and discussions of interest both to our members and to the municipal officials.

Mr. L. I. Birdsall, Chairman of the Section, in his opening address outlined carefully the purpose of the American Water Works Association and its Sections. He drew the attention of the municipal officials to the advantages obtained from membership in the organization and urged that they obtain memberships for their water works superintendents. He outlined the accomplishments of the Minnesota Section up to the present time and offered suggestions for its future development.

Business Meeting

(*a*) *Committee on Membership:* Mr. A. F. Mellen, Chairman. This Committee presented a detailed report which showed that there were at present 48 active members and 1 corporate member, making a total of 49 members in the Minnesota Section on June 21, 1922. Attention was drawn to the fact that from April 1, 1921 to April 1, 1922 the Section had lost 10 members, 1 by death,

1 by resignation and 8 that had been dropped for non-payment of dues. These members have been replaced and 1 additional member added to the Section, making an increase in membership of one over that existing on April 1, 1921.

(*b*) *Committee on Publicity:* Mr. L. I. Birdsall, Chairman. This Committee had been active during the year and had made arrangements with the United States Public Health Service to provide copies of sanitary engineering abstracts to various members of the Section.

(*c*) *Place of next meeting:* The next meeting of the Section is to be held either in Minneapolis or St. Paul, at the same time as the joint meeting of the State Health Organizations. It was the opinion of many members of the Section that the plan of holding meetings at the same time and place as other organizations is distinctly advantageous, since it brings many persons in contact with the work and aims of the American Water Works Association.

(*d*) *Election of Officers:* The following were elected for the coming year: Chairman, J. W. Kelsey, General Superintendent, Bureau of Water, St. Paul, Minn.; Vice-Chairman, H. A. Whittaker, Director Division of Sanitation, Minnesota State Board of Health, Minneapolis, Minn.; Secretary-Treasurer, A. F. Mellen, Assistant Superintendent Water Purification Division, Water Works Department, Minneapolis, Minn.; Trustees, Charles Foster, Consulting Engineer, 512 Sellwood Building, Duluth, Minn. (to serve for three years); A. D. Horne, Supt. Water & Light Commission, Fairmont, Minn. (to serve for three years); C. M. Crowley, Water Registrar, Bureau of Water, 25 East 5th Street, St. Paul, Minn. (term expires in 1923).

The papers were of unusual interest, since all of them, dealing with water works problems, were of a practical nature. There was much discussion on the papers presented. These were as follows:

Safety Work Applied to Water Works, by George Martinson, Range Safety Inspector, Pickands-Mather & Co., Hibbing, Minn.

Details of Water Works Construction, by H. P. Wolff, Consulting Engineer, St. Paul, Minn.

Sane Finance for Water Works, by R. M. Goodrich, Executive Secretary, Taxpayers League, Duluth, Minn.

The Small Municipal Filtration Plant, by J. A. Childs, Engineer, Division of Sanitation, State Board of Health, Minneapolis, Minn.

Water Supplies Obtained from Iron Ore Mines, by Ole Forsberg, Oliver Mining Co., Hibbing, Minn.

Joint Meeting with the League of Minnesota Municipalities

During the latter part of the afternoon the members of the Section met with the League and entered into discussion of two of the League's committee reports, namely, Sanitation and Water Supply. This joint meeting appeared to be much appreciated by the members of the League and of our Section.

The city of Crookston is to be complimented on the entertainment provided for the guests of both organizations.

The meeting was attended by 36 members and guests in the forenoon and 50 members and guests during the afternoon. The total persons in attendance at the meeting of the Minnesota Section and the League of Minnesota Municipalities was about 225.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, **12:** 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Tentative Plans for the Construction of a 780-ft. Rock-Fill Dam, on the Colorado River at Lee Ferry, Arizona. E. C. LaRue. Proc. A. S. C. E., **48:** 4, 835, April, 1922. More than 4,000,000 continuous horse-power may be developed between Green River and Boulder Canyon. The aggregate installed capacity of the power plants would probably be more than 5,000,000 h. p. Lee Ferry Project. By building a dam at Lee Ferry to raise the water 700 ft., 1,000,000 h. p. may be developed at this site. The construction of high rock-fill dams by blasting down the towering canyon walls has been suggested in connection with the studies of both power and irrigation development. The raw materials necessary for the construction of rock-fill dam at this site are conveniently situated. The writer believes that a rock-fill dam properly constructed would be fully as safe as a concrete dam. The 20,000,000 acre-ft. of storage capacity of the upper 100 ft. of the Lee Ferry Reservoir may be sufficient to equalize the flow through the canyons of the lower river. With a 100 ft. drawdown, the average head available at Lee Ferry for power would be about 650 ft., and with the flow of the river equalized at this point, power plants in the canyon below could be operated under heads almost equal to the full height of the respective dams. The dam farthest down stream, however, should provide sufficient storage capacity to regulate the flow to conform to the demand for irrigation. Should this project be developed, water would be available for irrigation on the lower river for at least a generation to come, and the menace from floods would be removed (except floods from the Gila River).—*E. E. Bankson.*

Floods on Small Streams Caused by Rainfall of the Cloud-Burst Type. Gerard H. Matthes. Proc. A. S. C. E., **48:** 5, 1096, May, 1922. In about 150 years of records for Baltimore, Md., 9 floods of this type occurred at intervals averaging 17 years. With the Erie record the floods were separated by 15 and 22 year intervals. Smaller flood records at Denver, Colo., average 18 years apart, and at York, Pa., 9 floods have been recorded at intervals averaging 18 years. In the design of spillways it has been considered proper to build for the largest flood, and often an additional factor of safety may be introduced. As more data on cloudburst floods become available, the tendency is to build larger and larger spillways, The retarding-basin system, however, offers special advantages for handling this class of floods, as the total flood run-off is not large and does not require basins of great size.—*E. E. Bankson.*

Buffalo Water Consumption Falling, but Still High. GEORGE C. ANDREWS. Eng. News-Record, **88**: 950, 1922. Due to campaign against excessive water waste, the daily per capita consumption has fallen from 339 for 1916–7 to 227 gal. for 1921–2. The pumpage for the same period declined from av. of 168 to 117 m. g. d.—*Frank Bachmann* (*Courtesy Chem. Abst.*).

Water Company Sued for Typhoid Damages.—ANON. Eng. News-Record **88**: 951, 1922. Suits for damages totaling $300,000 have been brought against the Blue Ridge Water Supply Co., Walnutport, Pa., by 30 residents who allege that the supplying of polluted water caused typhoid, sickenss and death. Of 53 cases, 80 per cent had onset from June 13 to 21, 1921. State engineer attributes cause to contaminated spring used as auxiliary supply.—*Frank Bachmann.* (*Courtesy Chem. Abst.*).

Ohio Cities Cannot Divert Water Revenues. ANON. Eng. News-Record, **88**: 1028, 1922. The Ohio Supreme Court upheld the decision of the Lower Court which limited earnings of municipally owned waterworks to operation, maintenance, extensions and debt charges. Cincinnati desired to transfer $500,000 of waterworks, revenue to relieve general taxation.—*Frank Bachmann* (*Courtesy Chem. Abst.*).

Perforated Pipe Underdrains for Alpena Water Filters. WILLIAM G. CLARK. Eng. News-Record, **88**: 1048, 1922. The 4 filters of the new 3 m.g.d. water purification plant for Alpena, Mich., will be provided with the perforated pipe type of underdrains.—*Frank Bachmann* (*Courtesy Chem. Abst.*).

Public Health and Sanitary Engineering Work at Harvard Revised. ANON. Eng. News-Record, **89**: 76, 1922. The Harvard School of Public Health will take the place of the school conducted jointly by Harvard Univ. and M. I. T. *Frank Bachmann* (*Courtesy Chem. Abst.*).

Twenty Years' Filtration Practice at Albany, N. Y. G. E. WILLCOMB. Eng. News-Record **88**: 879, 1922. Four distinct steps in method of treatment of water have been introduced:—(1) Slow sand filtration from 1899 to 1908; (2) double filtration commencing with 1908; (3) introduction of Cl in 1909; and, (4) coagulation followed by the by-passing of the preliminary filter effluent around the slow sand units. These steps show that a gradual change from slow sand to rapid sand filtration has taken place.—*Frank Bachmann* (*Courtesy Chem. Abst.*).

Efficiency of Coke Aerating Towers (Riesslers) in Iron Removal. DR. KARL KISZKALT. Gas- und Wasserfach, **65**: 37, 1922. Experiments on a riessler to which gelatine had been added as a protective colloid, to prevent the coagulation of colloidal iron. The amount of uncoagulated iron leaving the riessler was not dependent on the amount of iron entering with the raw water, but rather on the amount of iron removed by the tower. This throws the burden of the iron removal on the filters which follow the riessler, if the tower fails to remove the dissolved iron and at the same time to coagulate the iron in suspension.—*Jack J. Hinman, Jr.*, (*F.M.*) (*Courtesy Chem. Abst.*).

The Action of Open and Closed Filters in Iron Removal. KARL KISZKALT. Gas- und Wasserfach, **65**: 85–86, 1922. To determine whether open or closed filters were best after passing water through coke aerating tower (riessler). An open slow sand filter with an area of 1 sq. meter; a closed filter with a surface area of 6 sq. meters and capacity of 50 cu. meters; an aerating tower of 33 sq. meter surface area and a capacity of 100 cu. meters per hour were used. The raw water contained 2 to 4 p. p. m. iron. Slow sand filter did not remove all iron from 1 cu. meter after aerating. Closed filter removed all iron from 50 cu. meters of the water after aeration.—*Jack J. Hinman, Jr.,* (*M.F.*) (*Courtesy Chem. Abst.*).

Modern Methods of Preserving the Purity of Water Supplies. GEORGE R. TAYLOR. Penna. W. W. Assn. Report, 1921, page 28. The first line of defense in preserving purity is the collecting area. With small watersheds it is possible to buy the watershed. On the populated watershed strict sanitary control should be maintained as to household wastes, the house privy, etc. For the remedy on farms and for small groups of houses the work should be done by the utility combined with tactful handling. The expense for trade wastes and sewage should be borne by those producing them. However, if you want anything done, do it yourself. The second line of defense is the impounding reservoir giving sedimentation and germicidal effect of sunlight. Final surety of the water supply can only be secured through filtration or steriliztion or both. The ideal is the eventual filtration of all surface supplies and the writer believes that chlorination should be adopted at once for every surface supply in the State.—*E. E. Bankson.*

Wood Pipe for Water Supply Mains. E. R. HANNUM. Penna. W. W. Assn. Report, 1921, page 47. In 1907 the Windber Water and Power Company constructed a wood pipe gravity water supply line eight miles in length and 24 inches to 16 inches diameter. The first 5 miles from reservoir fairly satisfactory under 43 pounds pressure. The next 2 miles, to 47 pounds pressure, is unsatisfactory as originally built. The remaining mile of 20-inch wood under 44 to 108 pounds pressure leaked from the start and after seven years the staves began to burst where knots run transversely of stave. In 1916 we replaced this last mile, again with wood. After two years trouble began and after four years the same transverse knot trouble started. We have laid a 10-inch cast iron line paralleling this last mile for use when repairing wood pipe. Our experience condemns wood stave pipe, mortise and tenon type, subject to pressure of 50 pounds or more and at 25 pounds, leaky joints are likely to develop.—*E. E. Bankson.*

Some Observations Concerning Water Works Supply Mains. J. W. LEDOUX. Penna. W. W. Assn. Report, 1921, page 42. For a conduit or supply main practically all types are used depending on the circumstances, cast iron, wrought iron, steel, reinforced concrete, wood or terra cotta. There are several vital precautions that should be taken when adopting wood pipe. Of installations of wooden pipe, probably at least 25 per cent have given good satisfaction. In

this respect, cast iron pipe is of great advantage in being "fool-proof." Reinforced concrete is coming more into use for supply mains.—*E. E. Bankson.*

Forestry for Water Companies. W. B. McCaleb. Penna. W. W. Assn. Report, 1921, page 86. Owners of timber lands have been greatly discouraged by the frequency and destructiveness of forest fires. The protection by the State is now well organized and will prove its value the first dangerous fire season. The Department advises that they have available for free distribution in 1922 four million forest tree seedlings and transplants. The kind of trees to plant will be printed in the Proccedings. Under favorable conditions one thousand feet board measure per acre per annum may be secured for a period of fifty years. Many water companies in the New England district have been successful in obtaining a satisfactory return. Therefore, the practice of forestry offers to water companies the possibility of profit.—*E. E. Bankson.*

Decisions of the Courts and Public Service Commissions during the Year, Affecting Water Companies. C. LaRue Munson and Edgar Munson. Penna. W. W. Assn. Report, 1921, page 102. (1) If water companies obey the law with regard to service and rates, there cannot be any municipal competition. (2) No act can be passed by the Legislature conflicting with the Act of 1874 regarding the price for the purchase of a waterworks by a municipality. (3) When your rates are filed to take effect they are all payable after the effective date of the new rate, notwithstanding any contest. (4) The Supreme Court of the United States made the important ruling in the Ohio Valley Case that every utility is entitled to the opinion of a Court (upon its own independent judgment), as to the facts controlling its valuation and rates, and that the Commission is not a Court. The result of that decision was that there are now two bodies to pass upon these questions of valuations,—the Commission and the Superior Court,—and the Supreme Court of Pennsylvania has added that they must be permitted to examine into the facts sufficiently to find that the evidence justifies the findings. (5) The Supreme Court of Pennsylvania says that the Commission has no control over "Rentals paid underlying companies." No contract made by a utility is subject to a direct attack and revision, unless it is itself a rate contract. . . . If the statute gives to the Commission the power to reduce these rentals it may also increase them. . . . The law gives neither right. (6) But now comes a statute of the Pennsylvania Legislature, which allows a borough or a city to appoint a Commission to so regulate the mining of coal within the limits of that borough or city or township of the first class, as to prevent the digging out of that coal, if thereby the surface will subside. Water companies are interested in the result of that case. (7) The Supreme Court of the United States has spoken, in no uncertain terms, that the stockholders of a utility are entitled to the present value of property. Is it the five or ten year average of prices or is it present value?—*E. E. Bankson.*

Review of Cases. Ohio Valley Water Company Case, Superior Court. The item of going value held properly allowable is $185,000 and $92,415 should be added for brokerage. **Beaver Valley Water Company Case.** Preliminary costs

of promotion, construction and brokerage, $100,000. "Going concern" value at least $175,000. **Amortization of Rate Case Expenses.** Should not be "loaded on one year," but amortized over a period of three or more years. **Discrimination.** The service of the utility cannot be misapplied, and the cost imposed upon other shoulders. Rates should be uniformly applied. Any service rendered at other rates results in discrimination. When service is rendered to all consumers in the same class at the same rates, no unjust discrimination exists. Rates established by legally filed tariffs are the *only* legal rates. **Municipal Contracts.** Rate contracts with municipalities, individuals, or private corporation, are subject to rate-making power vested in the Commission, and where the common weal demands, the contract shall be modified. **Mercersburg, Lehmasters & Marks Electric Co. Case, Superior Court.** It seems to us to be plain that too much consideration of the element of original cost is just as likely to mislead an administrative tribunal as a jury. The Commission must have rested its finding largely, if not entirely, upon an undue consideration of original cost. **Mountain City Water Co. Case.** The Commission held that the ten-year average should be adopted. (**Other Items** of interest in all decisions for the year are touched upon, with index of Subjects and Cases.)—*E. E. Bankson.*

The Propriety of the Service Charge for Water Service. George W. Biggs, Jr. Penna. W. W. Assn., 1921 Report, page 193. In only one or two instances out of twenty cases for our Company have the new rates been made upon scientific lines. An earnest effort should be made to establish rates on a scientific basis and eliminate the present discriminatory features. It is generally conceded that the meter minimum is discriminatory. The service charge, on the other hand, eliminates this discriminatory feature. In the writer's opinion, the service charge should include all elements of cost of operation of keeping the entire plant filled with water, under pressure, ready to serve but not actually serving. The Pennsylvania Commission said: "Readiness-to-serve" includes those items of expense of keeping the gas or water in the pipes ready to be used. A recent paper before the American Water Works Association pointed out that the "maximum service charge" makes the service charge so high and the rate for water so low that it approaches a flat rate basis of charge and nullifies the benefits of metering.—*E. E. Bankson.*

The Hot Springs in North Island, New Zealand (Note). Water & Water Eng. (London), **24**: 225, June 20, 1922. The sulphuric acid waters of the Rotorua Springs in North Id. are used as baths and have a natural heat of from 85 to 105°F. These acid baths have proved of great value in all "rheumatic" conditions, in rheumatoid arthritis and in anemia. In the neighborhood are several other spas whose waters possess alkaline, sulphur, and other properties.—*Geo. C. Bunker.*

Measuring 365 Million Gallons per Day (Notes). Water & Water Eng. (London), **24**: 225, June, 1922. An order has just been issued by the Metropolitan Water Board for 3 Kent Venturi meters, each 108 in. in diameter, for the new Littleton reservoir. These meters, when installed, will be the largest

in use in the United Kingdom, and the second largest manufactured in England, the largest being 120 in. in diameter for the Divi Irrigation Works, Madras, about 15 years ago. The recorders to work in conjunction with these tubes are of the water column type, the tubes being placed on the gravitation mains from the reservoir.—*Geo. C. Bunker.*

Hydrogen-ion Concentration in Natural Water. J. T. SAUNDERS. Proc. Cambridge Philosophical Soc., no. 20, 350, 1921. Abstract, Water & Water Eng. (London), **24**: 227, June 20, 1922. The concentration in waters taken from streams, lakes, and wells in chalky soil or subsoil is fairly constant, the well and ground water ranging between pH 7.1 and 7.2; that from streams between pH 8.25 and 8.5. In large and deep ponds and lakes the concentration remains fairly constant between pH 8.25 and 8.5, but drops in smaller bodies.—*Geo. C. Bunker.*

Chester Waterworks: Past and Present. FREDERICK STORR AND C. WILFRID BENNETT. Water & Water Eng. (London), **24**: 193, June 20, 1922. There are well supported proofs that the Romans, when they had established their rule in Britain, installed a water works. Pieces of pipe, made of lead and about 4 inches in diameter, were recently found in one of the streets and on one length there was the following inscription dated A. D. 79; "that this pipe was made when Julius Agricola was Governor of Britain." The water supply is taken from the River Dee (Riverside Works) and pumped to the Tower Works where the original slow sand and the roughing or rapid sand gravity filters are located. The available filter area of the slow sand filters is 74,850 sq. ft. The typical section is as follows: perforated bricks on filter bottom, 4½-in.; pebbles passing ¾-in., 4-in.; fine pebbles passing ¼-in., 2-in.; coarse pit sand, 60 per cent retained on 40 per inch mesh, 1 ft. 3 in.; fine pit sand, 65 per cent retained on 70 per inch mesh; 1 ft.; coarse pit sand, 60 per cent retained on 40 per inch mesh, 1 ft. 3 in. total depth, 4 ft. 4½-in. This form of filter has been in use for many years, and; yields exceptionally good results. The interposition of the layer of fine sand has been the subject of much criticism, but it has stood the test of time, and there is no doubt the remarkable results obtained are in a great measure due to its action. Due to the heavy load thrown on these filters due to the varying conditions of the river, 6 reinforced concrete rapid sand filters, each 24 by 12 ft. in plan by 8 ft. deep, were added to serve as roughing filters. The filtering material consists of 4 ft. of Leighton Buzzard sand over graded pebbles. The maximum rate of filtration is 86.8 gal. per sq. ft. per hour. No coagulant is used. An air wash is used in connection with a water wash. The cleanings vary with the state of the river from a maximum of 11 cleanings in one day to a single cleaning in 5 days. Before these filters were installed the slow sand filters required cleaning in the winter months every 7 to 12 days; after they were installed some of the slow sand filters have run for 5 months between cleanings. Attention is called to the fact that the same very moderate water rate, fixed some 65 years ago, is still in use.—*Geo. C. Bunker.*

The Recovery of Oil and Grease from Technical and Industrial Sewage. BRUNO SIMMERSBACH. Chem. Ztg., **45**: 887–90, 1921. From Chem. Abst. **16**:

306, January 20, 1922. Various methods for the recovery of grease from sewage are described, including drying the sludge and extracting grease with benzene or trichloroethane; centrifuging yielding a by-product which can be used as fuel; and oil traps which extract oil and grease of the water alone. The O.M.S. system is used successfully in the treatment of industrial wastes. The water is freed from suspended matter and the oil and grease collected from the surface and purified.—*R. E. Thompson.*

Free Alkalinity in Glass Containers. A. W. Bitting. Glass Ind., **2**: 235–7, 1921. From Chem. Abst., **16**: 322–3, January 20, 1922. Results of experiments indicate that American bottles, including flint, blue, green, and amber glasses, have a free alkalinity which is practically negligible except for particularly accurate work. The containers were filled to capacity with dilute sulphuric acid and also with distilled water and allowed to stand from 1 to 48 hours. The average results, expressed in milligrams of sodium hydroxide per liter, ranged from 0.40 for a 250-cc. bottle to 26.64 and 33.92 milligrams for a 5 cc. container. The results were approximately doubled on standing two weeks, but increased very slowly with longer standing.—*R. E. Thompson.*

Some Examples of Corrosion of Reinforcing Steel. F. P. McKibben. Eng. News-Record, **87**: 531–32, 1921. From Chem. Abst., **16**: 325, January 20, 1922. Fourteen structures inspected showed corrosion of reinforcing steel due to chemical action, generally caused by the presence of salt. The steel rods rusted, thereby increasing in diameter and resulting in cracks in the concrete parallel to the rods. These fourteen structures are contrasted with many thousands of others which are rendering good service.—*R. E. Thompson.*

Hard Water in Silk Hosiery Dyeing. H. L. Tiger. Textile World, **60**: 2299–2303, 2314, 1921. From Chem. Abst., **16**: 345, January 20, 1922. Water containing 5.5 grains of hardness is disadvantageous in the boiling off and dyeing of silk.—*R. E. Thompson.*

Rusting Caused by Carbonic Acid. G. Bruhns. Chem.-Ztg. **45**: 885–7, 1921. From Chem. Abst., **16**: 230, January 20, 1922. Carbon dioxide in boiler feed water, occurring in the free state or formed as a result of the decomposition of bicarbonates, will cause rusting. The ferrous carbonate formed is immediately hydrolyzed to iron hydroxide and the carbon dioxide thus liberated causes the rusting process to be repeated. If nitrates are present, nitric acid is formed and the corrosion is greater. Careful treatment of the feed water provides ample protection against rusting.—*R. E. Thompson.*

The Determination of Bromine in Saline Waters. Lebeau and Picon. Bull. soc. Chem., **29**: 739–43, 1921. From Chem. Abst., **16**: 217–8, January 20, 1922. The following modification is suggested for Figuier's volumetric method for the determination of bromine, which was found to give inaccurate results due to the presence of halogen acids. The bromine is liberated with chlorine water and extracted with chloroform. The chloroform extract is then treated

with potassium iodide and the liberated iodine titrated with standard sodium thiosulphate. This mehod gives result with an accuracy of 1 per cent.—*R. E. Thompson.*

Measurement of Hydrogen-ion Concentration. G. W. MONIER-WILLIAMS. Analyst, **46**: 315–24, 1921. From Chem. Abst., **16**: 219. January 20, 1922. A brief description of, and notes on, the electrometric method of determining H-ion concentration.—*R. E. Thompson.*

A B. Coli-Inhibiting Medium for Paratyphoid. B. K. PESCH. Centr. Bakt. Parasitenk., Abt. 1, **86**: 97–101, 1921. From Chem. Abst., **16**: 271, January 20, 1922. An agar medium containing 0.19 per cent ammonium sulphate as the source of nitrogen and 1 per cent sodium citrate as the source of carbon will inhibit the growth of B. coli, B. typhosus and B. paratyphosus A. When the sodium citrate was replaced by 1 per cent potassium tartrate, B. coli and B. paratyphosus B. grew while B. paratyphosus A and B typhosus were inhibited.—*R. E. Thompson.*

The Ionization Constants of Glycerophosphates and Their Use as Buffers, Especially in Culture Mediums. R. R. MELLONS, S. F. ACREE, P. M. AVERY AND E. A. SLAGLE. J. Infect. Dis., **29**: 1–6, 1921. From Chem. Abst., **16**: 271, January 20, 1922. The fact that the ionization constants of glycerophosphates are substantially the same as those of the nonglycerolated phosphates makes possible the substitution of these salts as buffers in culture media. The greater stability of these salts in the lower alkaline ranges prevents much of the objectionable precipitation of phosphates in media after autoclaving.—*R. E. Thompson.*

The Cement Gun in Water Works Construction. H. A. HAMMICK. The Surveyor, **61**: 191, February 24, 1922. Some of the difficulties experienced in plastering a water reservoir by means of a cement gun are described. It was found that the nozzle of the gun should be approximately normal to the surface at a distance of two feet, and kept gently in motion. It is estimated that the cost of applying ½ inch of Gunite to a large flat surface would be approximately equal to the cost of ¾ inch of hand-placed plaster, and would be a much better protection.—*R. E. Thompson.*

Investigation by Means of the Hydrogen Electrode of the Chemical Reactions Involved in Water Purification. R. E. GREENFIELD with A. M. BUSWELL. Jour. American Chemical Soc., **44**: 1435–42, 1922. The hydrogen electrode is used to follow the course of reactions occurring in water softening and purification. Reactions studied were titration of $CaCO_3$ and $MgCO_3$, precipitation of $CaCO_3$, $Mg(OH)_2$ and $Al(OH)_3$. Data show: 1. Phenolphthalein and methyl orange are suitable indicators for titration of carbonate solutions; 2. Precipitation of magnesium as hydroxide did not start until the pH value reached 9.0, and was complete at pH 10.6; that precipitation of Ca as carbonate was complete at pH 9.5; and that $Al(OH)_3$ started precipitation in solution as acid as pH 4 and to be completely precipitated at pH 6.5 to 7.5. At higher values, reso-

lution started and was complete at a value between pH 10 and 11. Further studies are being made on precipitation of $Mg(OH)_2$ and $Al(OH)_3$.—*Charles P. Hoover.*

Report of Committee on Water-Works and Water Supply. NICHOLAS S. HILL, Chairman. Proc. American Society of Municipal Improvements, 1921 Convention: 60–73. A résumé of the status of water supply practice in 1921 is given. The committee calls attention to the desirablilty of keeping the operating force at the highest standard possible by paying adequate salaries, and to the need of establishing more equitable water rates. Other subjects, such as uniform accounting, standardization of materials, pumping machinery, rainfall and run-off records, distribution systems, standards for water quality, water softening, water supply and diseases, water purification and electrolysis, are briefly discussed.—*John R. Baylis.*

Maintenance and Restoration of the Purity of the Water Supply of Baltimore. JAS. W. ARMSTRONG. Proc. American Society of Municipal Improvements, 1921 Convention: 90–100. Preventing contamination of the Baltimore water supply has been partly accomplished by purchasing land and systematic inspections of all premises on the watershed. Moral suasion and good natured persistence have been the means of getting rid of the worst sources of pollution. Over one million trees, mostly white pine and spruce, have been planted on land owned by the City. Additional forestration is recommended. Work was started in March, 1921, on raising the level of the Loch Raven dam to form a storage reservoir of about 23 billion gallons capacity. A new tunnel from the reservoir to Montebello Filters is recommended, but at present a balancing reservoir will be constructed to prevent excessive pressure on the present tunnel. The method of treatment at the Montebello Filters is briefly outlined.—*John R. Baylis.*

Water Supply of Baltimore. V. BERNARD SIEMS. Proc. American Society of Municipal Improvements, 1921 Convention: 74–89. A brief history of the water supply of Baltimore from the first attempt to establish a supply in 1787 to the present time. Mr. Siems outlines the need of additional pumping stations and extension of the distribution system. The pitometer survey now in progress has covered approximately 10 per cent of the area, has cost $20,000 and has effected a saving of about 6 million gallons daily. In 1920 eighteen inspectresses located 28,227 leaks of which 1,633 were turned off because of non-compliance with notice to repair. Estimated saving from house inspection is 5 million gallons daily.—*John R. Baylis.*

SUBJECT INDEX

AUTHOR INDEX

INDEX TO ABSTRACTS

I. Authors

INDEX TO ABSTRACTS

II. Subjects

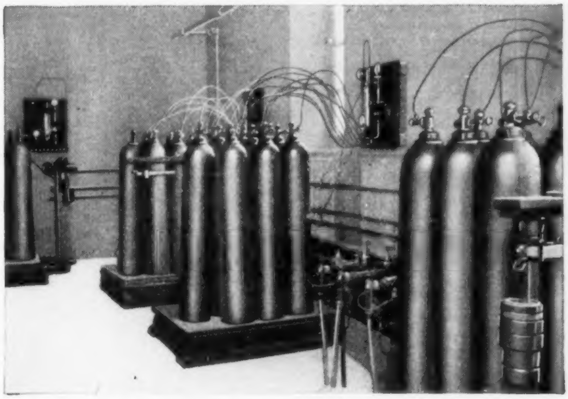
ADVERTISEMENT SECTION

ALPHABETICAL LIST OF ADVERTISERS

DIRECTORY OF EXPERTS

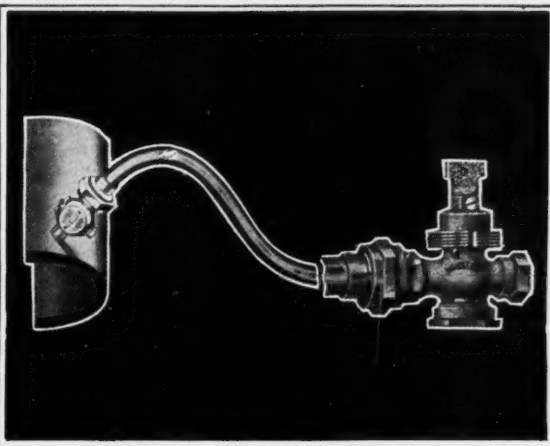
THE A. P. SMITH MANUFACTURING COMPANY
EAST ORANGE **NEW JERSEY**

A TRIDENT FOR EVERY SERVICE!



Water leaving the Kensico Reservoir is treated with Liquid Chlorine and W & T equipment


MUELLER



NEW YORK OFFICE

DON'T FORGET

that the Association has headquarters in New York City, where the Secretary is ready to be of service to the members when possible. When in the City call at the office—make it your headquarters. Have your mail directed there if you have not made hotel reservations, and then come to the office for it, or direct the Secretary where you wish it sent. Jot the address and telephone number down in your note book NOW, so as to have it when needed.

AMERICAN WATER WORKS ASSOCIATION

153 West 71st Street **Telephone Columbus 9546**

IMPORTANT

OWING to an unexpectedly large number of new members since the first of January, we have run short of certain numbers of the Journal for the current year. Any members who are not interested in preserving their journals and are willing to return same to the Secretary's office will be conferring a favor upon the Executive Committee and acting to the benefit of the Association.

J. M. DIVEN, Secretary,
153 West 71st Street,
New York City.